

The Journal of the Indian Botanical Society

Vol. XXXVIII

1959

No. 4

NOTES ON FUNGI FROM NORTH-EAST INDIA

IV. Myxomycetes (*Continued*)

BY V. AGNIHOTHRUDU

Tocklai Experimental Station, Indian Tea Association, Cinnamara, Assam

(Received for publication on April 1, 1959)

27. *Fuligo septica* (L.) Weber; Wiggers in *Primitiae flora holsaticae quas praeside D. Ioh Christiano Kerstens*, p. 112, 1780; Lister, A., *A Monograph of the Mycetozoa*, pp. 66–68, 1925, as *Fuligo septica* Gmelin; Martin, G. W., *North American Flora, Fungi-Myxomycetes*, pp. 94–95, 1949; Agnihothrudu, V., *J. Indian bot. Soc.*, **33**, p. 182, 1954; Thind, K. S. and Rehill, P. S., *Indian Phytopathology*, **10**, pp. 88–90, 1957.

This species appears to be quite abundant in and around Tocklai Experimental Station. The forms occurring are somewhat smaller than those reported from Madras (Agnihothrudu, 1954 *b*) and measure about 2.5 cm. in diameter. The collections are invariably deep-brownish with flecks of whitish peridium. Pink-coloured aethalium was once collected. The capillitium is dense, calcareous and typically physaroid with small transversely arranged, fusiform, calcareous knots. Irrespective of the size and variation in colour, all of them have a typical labyrinthine structure of the aethalium similar to the familiar gyrose rosettes of *Physarum gyrosum* Rost., which is also common here but the two species were never found occurring together. *P. gyrosum* in most cases was found to be terrestrial in habitat. *Fuligo septica* in all instances possessed a well-developed cortex.

On decaying litter between tea bushes, Tocklai, Coll.: V. A., 10–3–1957 (M.H.T.E.S. No. 64); on wood of undetermined host, Jorhat Coll.: H. K. P., 14–3–1957 (M.H.T.E.S. No. 65); on bark of *Mesua ferrea* L., Jorhat, Coll.: H. K. P., 17–8–1957 (M.H.T.E.S. No. 66); on decaying vegetable litter found on soil, Jorhat, Coll.: H. K. P., 17–8–1957 (M.H.T.E.S. No. 67); on undetermined leaf found in decaying vegetable debris, Tocklai, Coll.: V. A., 4–3–1958 (M.H.T.E.S. No. 68); the latter is a slightly pinkish coloured form with the cortex somewhat reduced than in other collections reported here. On decaying tea bark, Tyroon, T. E., Coll.: V. A., 16–4–1958 (M.H.T.E.S. No. 69); on stems of an undetermined dicotyledonous weed, Jorhat, Coll.: H. K. P., 1–8–1958 (M.H.T.E.S. No. 70).

28. *Badhamia viridescence* Meylan in *Bull. Soc. vaud. Sci. Nat.*, **53**, p. 452, 1921; Lister, A., *A Monograph of the Mycetozoa*, p. 20, 1925.

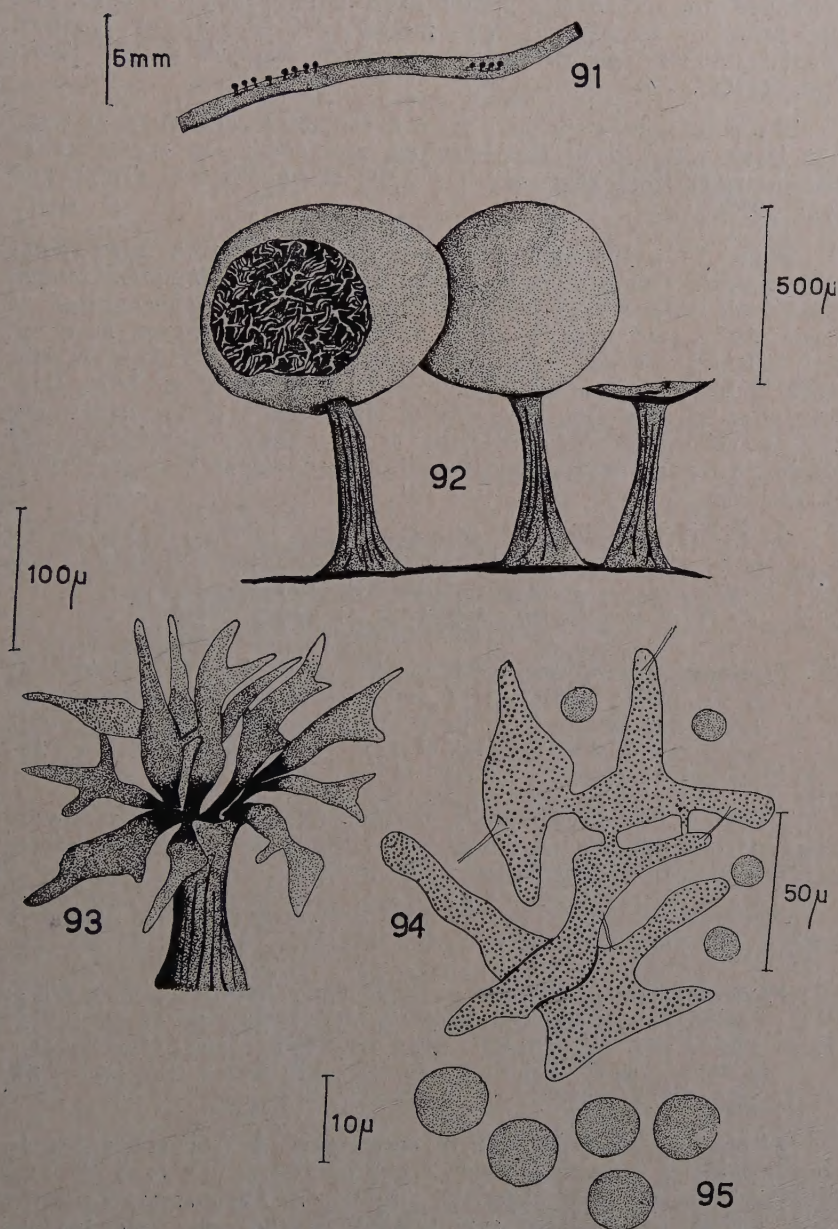
Sporangia collected only twice on decaying leaves of *Artocarpus integrifolia* L. Total height of the sporangia up to 1.2 mm., scattered to subgregarious, stalked, subglobose to spherical, measuring up to 0.75 mm. in diameter, lemon-coloured or citron yellow, rugulose, sporangial wall densely charged with calcareous granules, mottled when old and mature, coloured somewhat orange-yellow near the base; peridium breaking away in fragments exposing the well formed capillitium and the spore mass; stalk pale-yellowish with a slight coppery tinge, subulate, completely free from refuse matter, measuring up to 0.4 mm. in height; capillitium a dense network of tubes enclosing pale yellowish to ivory white lime granules, with a few connecting hyaline threads. Spores pale violaceous-brown, spherical, minutely warted, measuring 8-11 (-12) μ in diameter (Text-Figs. 91-95).

This species appears to be rather rare. Although the forms collected here bear a superficial resemblance to *Craterium aureum* (Schum.) Rost., they could easily be distinguished from the latter in possessing the typical badhamoid capillitial tubes and in the presence of paler and larger spores. Besides, *Badhamia viridescence* lacks a pseudocolumella which is conspicuous in some members of *Craterium aureum*.

Only one collection is preserved: on the bark, twigs and leaves of *Artocarpus integrifolia* L. Cinnamara, T. E., Coll.: V. A., 21-2-1957 (M.H.T.E.S. No. 71).

29. *Physarum cinereum* (Batsch) Persoon in *Neues Mag. Bot.*, **1**, p. 89, 1794; Lister, A., *A Monograph of the Mycetozoa*, p. 53, 1925 as *Physarum cinereum* Pers.; Martin, G. W., *North American Flora, Fungi-Myxomycetes*, p. 105, 1949; Thind, K. S. and Sohi, H. S., *Indian Phytopathology*, **8**, pp. 150-51, 1955.

Plasmodium watery-white to pale-yellow, or almost colourless, often spreading on grasses and weeds growing in between the tea bushes. The fructifications were observed to smother the leaf blades of lawn grasses. Fructifications are typically sporangiate, sessile, globose, subglobose or pulvinate, often heaped up and crowded. In most of the specimens collected the sessile individual sporangia scattered to densely gregarious, elongate or ellipsoidal merging into short plasmodiocarps measuring up to 0.5 mm. in diameter and up to 4 mm. in length, white, cinereous, rugose, without any discernible hypothallus. Peridium typically single, densely charged with lime granules, often flecked or mottled, dehiscing longitudinally and irregularly. The peridial wall drops off in flakes over the top of the sporangia (plasmodiocarps) exposing the white calcareous knots and purplish-brown spore mass. The peridium in some instances is persistent at the base of the fructification. Capillitium abundant consisting of branched hyaline threads connected with numerous white calcareous knots,



TEXT-FIGS. 91-95. *Badhamia viridescens* Meylan (M.H.T.E.S. No. 71). Fig. 91. Sporangia on a decaying twig. Fig. 92. Sporangial group, one of the sporangia shows capillitium, and another the persistent remnants of the peridial base. Fig. 93. Capillitium attached to the summit of the stipe. Fig. 94. The typical badhamoid capillitium with lime granules. Fig. 95. Spores.

varying in size and shape. Spores deep purplish-brown in mass, pale lilac brown in transmitted light, measuring 7-9 (-11) μ in diameter, spherical, almost smooth with a prominent eccentric guttule (Text-Figs. 96-101).

The collections made here have a capillitium consisting of small lime knots with almost *Badhamia*-like internodes; the spores unlike the specimens from Mussoorie have almost smooth wall (Thind and Sohi, 1955).

Some of the sporangia which are fairly large, with large spores and abundant lime present a close resemblance to *Physarum verum* Fries *sensu* Lister (1925), but the latter has always been described as having darker and rougher spores which features, however, have not been observed in the local form (Agnihotrudu, 1954 a). Martin (1949) treats *P. verum* as a synonym of *P. cinereum* as the original description of *P. verum* according to him is not in entire conformity with the conception that this species is more limy and predominantly plasmodiocarpous with larger and darker coloured spores than *P. cinereum*.

On leaves and twigs of *Mangifera indica* L. found in decaying vegetable litter. Tocklai, Coll.: V. A., 14-2-1957 (M.H.T.E.S. No. 72); on living leaves of dicotyledonous weed, *Murmuria* T. E., Coll.: V. A. and G. C. S. B., 17-7-1957 (M.H.T.E.S. No. 73).

30. *Physarum crateriforme* Petch in *Ann. royal bot. Gdn. Perad.* **4**, p. 304, 1909; Lister, A., *A Monograph of the Mycetozoa*, p. 49, 1925; Martin, G. W., *North American Flora, Fungi-Myxomycetes*, p. 112, 1949; Agnihotrudu, V., *J. Indian bot. Soc.*, **33**, pp. 180-81, 1954.

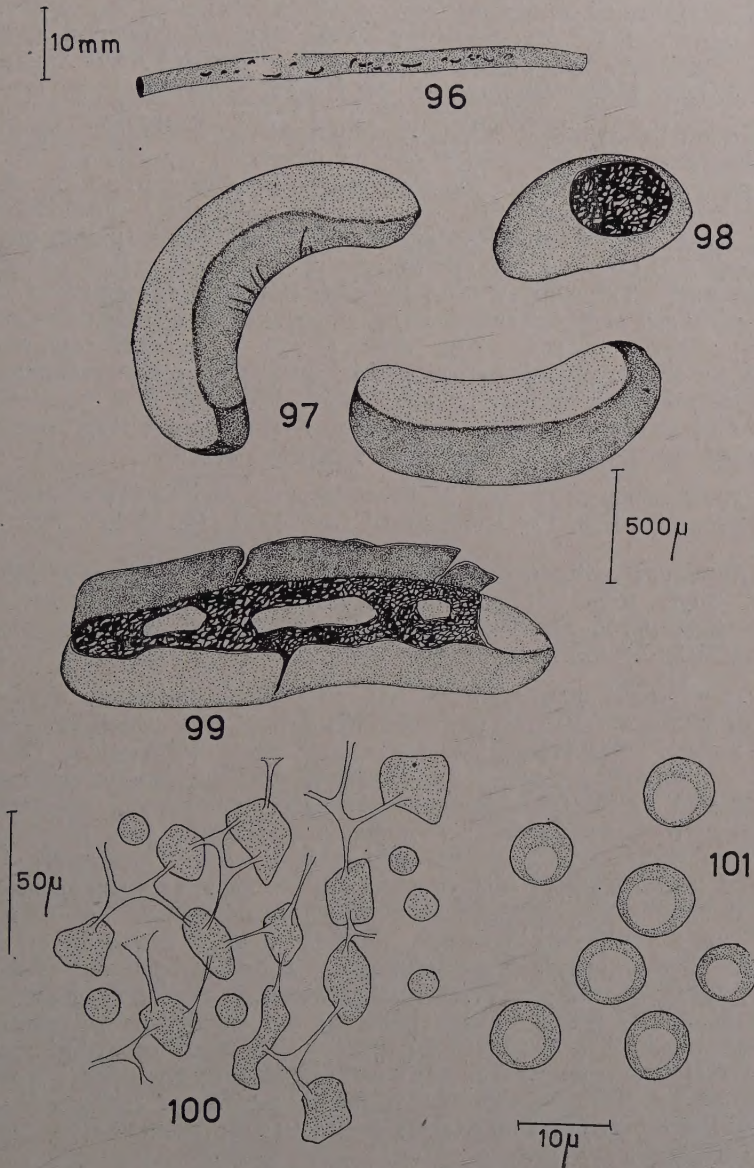
The form collected locally is comparable with the specimens reported from Madras (Agnihotrudu, 1954 a) in all respects except for the extremely reduced stipe which is hardly 0.2 mm. in height.

Only one collection is preserved: On decaying leaves of *Mangifera indica* L., Nazira, Coll.: G. C. S. B., 18-8-1957 (M.H.T.E.S. No. 74).

31. *Physarum nutans* Persoon in *Ann. Bot. Usteri.*, **15**, p. 6, 1795; Lister, A., *A Monograph of the Mycetozoa*, pp. 46-48, 1925; Martin, G. W., *North American Flora, Fungi-Myxomycetes*, p. 124, 1949; Agnihotrudu, V., *J. Indian bot. Soc.*, **33**, pp. 177-78, 1954.

This species is rather rare in occurrence. It is characterized by usually nodding sporangia which are produced at the ends of long, subulate, fuscous brown stalks and differs from *Physarum viride* (Bull.) Pers. (which it resembles superficially) in the absence of yellowish or orange coloured nodes intermingled with the capillitial reticulum.

On decaying fibrous roots of an undetermined lawn grass, Tocklai, Coll.: V. A., 10-2-1957 (M.H.T.E.S. No. 175).



TEXT-FIGS. 96-101. *Physarum cinereum* (Batsch) Persoon (M.H.T.E.S. No. 72).
 Fig. 96. Plasmodiocarps and sporangia on a decaying twig. Fig. 97. A short plasmodiocarp with peridium intact. Fig. 98. A sporangium showing the capillitium. Fig. 99. A short plasmodiocarp with reflexed peridial lobes. Fig. 100. Capillitial nodes and internodes. Fig. 101. Spores.

32. *Physarum leucophaeum* Fries in *Symbolæ gasteromycorum ad illustrandum floram suecicam*, p. 24, 1818; Lister, A., *A Monograph of the Mycetozoa*, pp. 47-48, 1925, as *Physarum nutans* Pers. var. *Leucophaeum* Lister; Martin, G. W., *North American Flora, Fungi-Myxomycetes*, pp. 117-18, 1949.

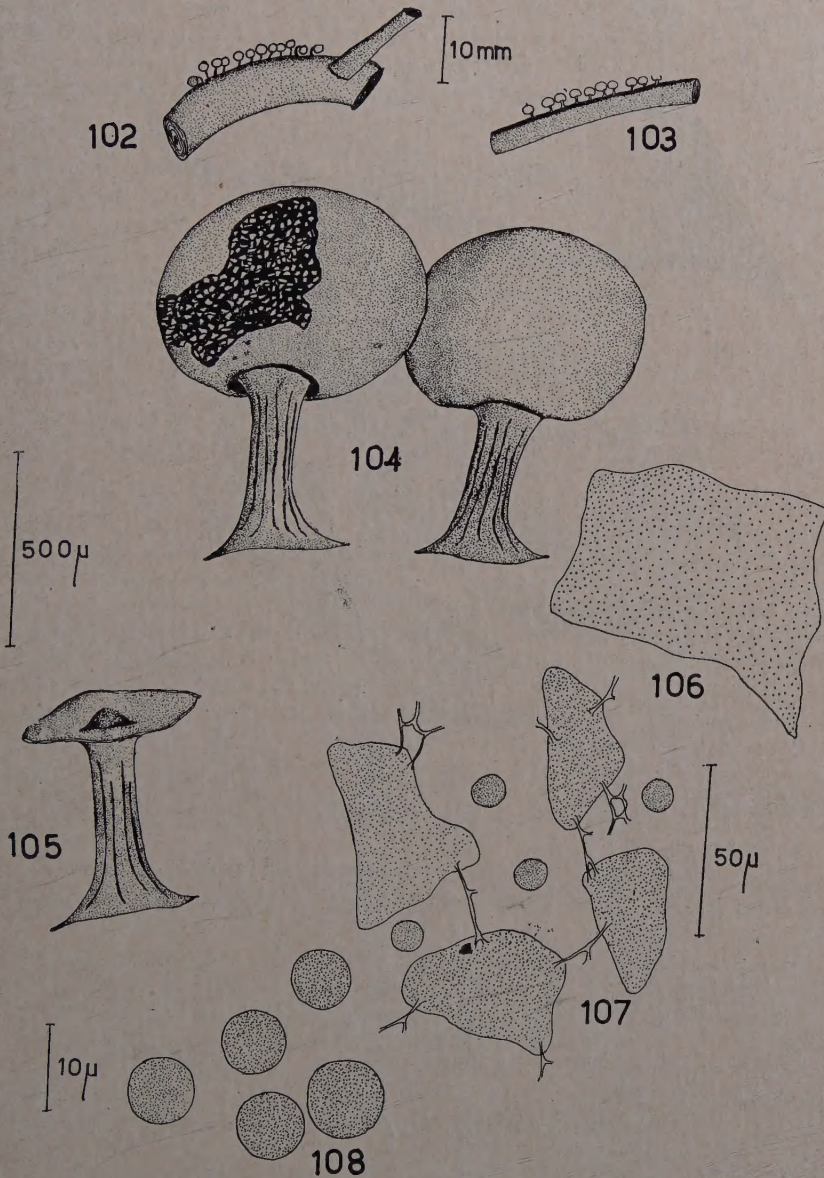
Sporangia typically stipitate, subgregarious, spherical to subglobose, measuring 0.5 to 0.75 mm. in diameter; total height of the sporangia up to 1.75 mm. No plasmodiocarpous or sessile forms were encountered. Peridium thin, membranous, iridescent, mottled with lime, somewhat densely impregnated with lime, rather umbilicate at the base. The peridium drops off leaving a shallow cup at the apex of the stipe. The stalk in some instances is prolonged somewhat into the sporangial cavity presenting the appearance of an incipient columella; capillitium dense, rather delicate, with a few calcareous nodes which are white, angular or of diverse sizes and shapes, interconnected by short, hyaline threads. Spores black in mass, deep violaceous brown in transmitted light, very finely verrucose to almost smooth, spherical, 8-10 (-11) μ in diameter (Text-Figs. 102-08).

On an undetermined leaf found in decaying vegetable litter between tea bushes, Tocklai, Coll.: H. K. P., 24-7-1957 (M.H.T.E.S. No. 75).

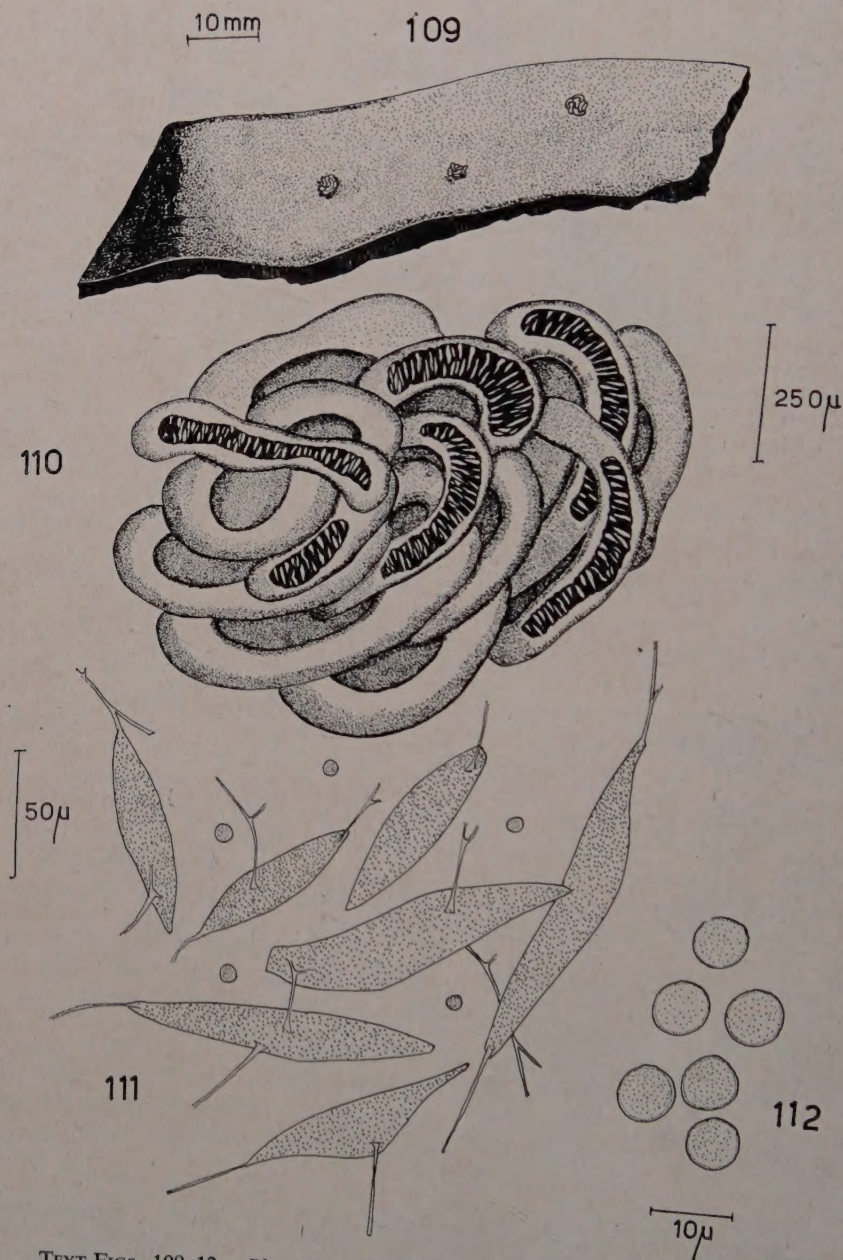
33. *Physarum gyrosom* Rostafinski in *Śluzowców (Mycetozoa) Monografia*, p. 111, 1874; Lister, A., *A Monograph of the Mycetozoa*, pp. 56-57, 1925; Martin, G. W., *North American Flora-Fungi-Myxomycetes*, p. 123, 1949.

This form is quite abundant and was often collected on decaying vegetable matter piled between tea bushes. It was equally common on soil too. Plasmodium watery or dirty-white with pale yellowish tinge. Sporangia are sessile and plasmodiocarpous, heaped up, much compressed by mutual pressure, labyrinthine and present the typical gyrose surface, measuring up to 4 mm. in diameter; pale bluish-grey in colour, seated on a well-developed pinkish brown hypothallus. The massed plasmodiocarps almost approach an æthalius in appearance and in aggregation. Individual plasmodiocarps are up to 0.5 mm. wide and about 1 mm. in height. The peridium is membranous, impregnated with clusters of lime deposits. The sporangial wall is fugacious, breaking away in small patches exposing the spore mass and the transversely arranged lime knots of the capillitium. Capillitium a dense tangle of delicate, hyaline threads with numerous white spine-like calcareous knots intermingled with small fusiform nodes; spores deep brownish in mass, pale lilac-brown in transmitted light, minutely but distinctly verrucose measuring 8-9 (-10) μ in diameter (Text-Figs. 109-12).

In some of the collections a strand-like weak, straggling stalk is present. The sporangial colonies are usually large and in one instance were found produced on a live *Tagetes* sp., at a height of about 25 cm. from the ground level. The yellowish-white plasmodium in this case had climbed the stem of the plant and smothered the leaves. The



TEXT-FIGS. 102-08. *Physarum leucophæum* Fries. Fig. 102-03. Fructifications on undetermined twigs. Fig. 104. Two sporangia one of which has sporangial wall intact, the other showing capillitium and calcareous knots. Fig. 105. The stipe with the persistent base of the peridium. Fig. 106. Peridial fragment. Fig. 107. Capillitium with calcareous knots and hyaline internodes. Fig. 108. Spores. (The collection from which the above figures were made is not represented in the herbarium.)



TEXT-FIGS. 109-12. *Physarum gyrosum* Rostafinski (M.H.T.E.S. No. 77).
 Fig. 109. Plasmodiocarps on the bark of decaying wood. Fig. 110. A heaped
 group of plasmodiocarps. Fig. 111. Capillitial knots with hyaline internodes.
 Fig. 112. Spores.

forms collected here bear an unmistakable resemblance to the plasmodiocarpous forms of *Physarella oblonga* (Berk. and Curt.) Morgan, but the internal lime knots which are whitish and not yellowish in colour as in the latter species offer an easy diagnostic feature. In most of the collections here the prevailing tints are bluish-grey but not pinkish.

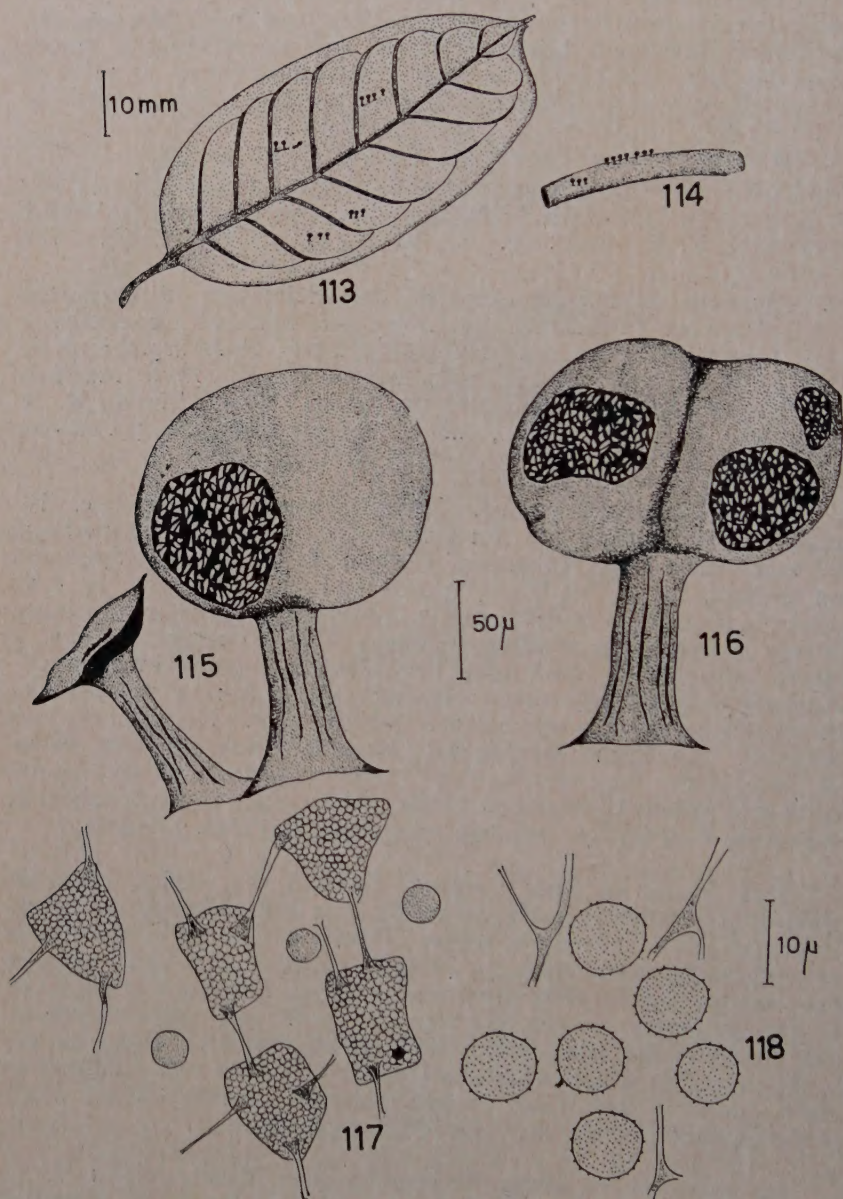
On living leaves of *Tagetes* sp., Tocklai, Coll.: V. A., 14-12-1957 (M.H.T.E.S. No. 76); on undetermined decaying wood, Jorhat, Coll.: H. K. P., 14-6-1958 (M.H.T.E.S. No. 77); on soil between tea bushes Cinnamara, T. E., Coll.: V. A., 23-11-1958 (M.H.T.E.S. No. 78).

34. *Physarum sulphureum* Albertini and Schweinitz in *Conspectus fungorum in Lusatiæ superioris agro niskiensi crescentium e methodo Persooniana*, p. 93, 1805; Lister, *A Monograph of the Mycetozoa*, pp. 26-27, 1925; Martin, G. W., *North American Flora, Fungi-Myxomycetes*, pp. 119-20, 1949; Thind, K. S. and Monocha, M. S., *Indian Phytopathology*, 10, pp. 102-04, 1957.

Plasmodium not observed. Sporangia gregarious, stipitate. No sessile or plasmodiocarpous forms were recorded here. The sporangia are erect when fresh, becoming prostrate with maturity. Sporangia are globose, subglobose, rarely pyriform, sulphur coloured, or olive yellow, measuring up to 0.75 mm. in diameter; peridium membranous, densely charged with small aggregations of lime granules that give a rugose appearance; stalk prominent, stout, pale yellowish-brown, distinctly longitudinally striate, subulate, arising from a well-developed hypothallus which is concolorous with the stipe. No columella was observed. Capillitium delicate, with abundant, loose, irregular yellowish lime knots, interconnected with short, hyaline threads. Spores violaceous brown by transmitted light, almost black in mass, spherical, measuring 8-10 (-11) μ , minutely verrucose (Text-Figs. 113-118).

This species is fairly abundant locally; the sulphur coloured, globose to subglobose sporangia with a pale reddish-brown or yellowish-brown stalk and lemon yellow calcareous granules of the species are sufficiently characteristic to facilitate identity. The forms collected here appear to differ from those reported from Mussoorie in the shape of the sporangia, in the absence of a prominent pseudocolumella. The spores of the local species are somewhat bigger. From the description of Thind and Monocha (1957 *loc. cit.*) it is rather difficult to make out their form from *Craterium aureum* (Schum.) Rost., which it seems to fit better than *Physarum sulphureum*.

On undetermined leaves, Entomology plots, Tocklai, Coll.: V. A., 14-12-1956 (M.H.T.E.S. No. 79); on decaying leaves of *Mangifera indica* L., Cinnamara, T. E., Coll.: V. A., 15-2-1957 (M.H.T.E.S. No. 80); on leaves and twigs of *Artocarpus integrifolia* L. found in decaying vegetable debris, Tocklai, Coll.: H. K. P., and G. C. S. B. 25-2-1957 (M.H.T.E.S. No. 81); on unidentified leaves, Tocklai,



TEXT-FIGS. 113-18. *Physarum sulphureum* Albertini and Schweinitz (M.H. T.E.S. No. 81). Figs. 113-14. Fructifications on leaf and twig of *Artocarpus integrifolia* L. Figs. 115-16. Sporangia showing the plicate well-developed stipe and capillitial knots. Fig. 117. Calcareous knots and non-calcareous internodes of the capillitium. Fig. 118. Spores.

Coll.: H. K. P. and G. C. S. B., 12-3-1957 (M.H.T.E.S. No. 82); on dried leaves of *Grevillea robusta* A. Cunn., Tocklai, Coll.: G. C. S. B. 10-4-1957 (M.H.T.E.S. No. 83); on dried leaves of bamboo, Jorhat Coll.: G. C. S. B., 24-7-1957 (M.H.T.E.S. No. 85); on leaves of *Pongamia glabra* Vent., Tocklai, Coll.: V. A., 10-2-1958 (M.H.T.E.S. No. 86).

35. *Physarum compressum* Albertini and Schweinitz in *Conspectus fungorum in Lusatiæ superioris agro niskiensi crescentium e methodo Persooniana*, p. 97, 1805; Lister, A., *A Monograph of the Mycetozoa*, pp. 49-50, 1925; Martin, G. W., *North American Flora, Fungi-Myxomycetes*, p. 122, 1949; Agnihotrudu, V., *J. Indian bot. Soc.*, **35**, pp. 210-11, 1956; Thind, K. S. and Sohi, H. S., *Indian Phytopathology*, **8**, pp. 151-53, 1955.

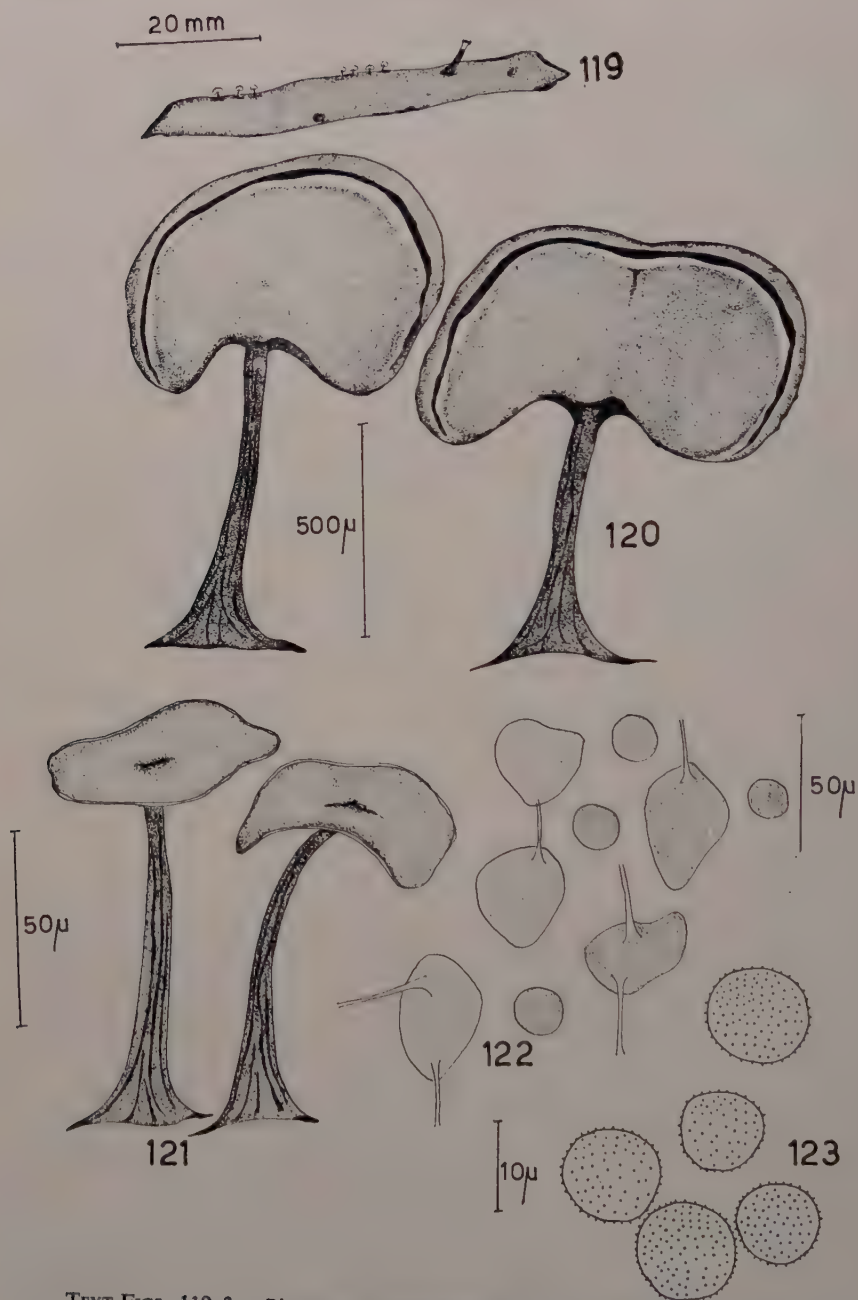
Plasmodium not observed. The typically sporangiate fructifications collected locally are somewhat different from those reported from Madras (Agnihotrudu, 1956 b). The sporangia measure about 2 mm. in height and the stalk is nearly 1-1.5 mm. long, deep brownish to almost black in colour, arising from a well formed, discrete hypothallus. The sporangial peridium dehiscs longitudinally along the apex of the compressed reniform sporangia. The peridial fragments are persistent at the base of the sporangium forming a shallow cup. The spores are distinctly spinulose and measure often up to 14μ in diameter (Text-Figs. 119-23).

The typically compressed sporangia splitting longitudinally along the upper narrow edge of the sporangium and the distinctly spinescent spores are very typical of the species and facilitate easy identification.

On twigs of *Albizzia procera* Benth., Borbhetta experimental plots, Coll.: V. A., 10-5-1957 (M.H.T.E.S. No. 92); on decaying twigs of tea, Tocklai, Coll.: V. A., 12-3-1957 (M.H.T.E.S. No. 93); on decaying tea bark, Cinnamara, T. E., Coll.: V. A., 10-11-1957 (M.H.T.E.S. No. 94); on leaves of *Musa paradisiaca* L., Jorhat, Coll.: H. K. P., 17-11-1957 (M.H.T.E.S. No. 95); on dead twigs of *Gliricidia sæpium* (Jacq.) Steudl. incubated in moist chamber, Tocklai, Coll.: H. K. P., 15-10-1958 (M.H.T.E.S. No. 96); on dead twigs of *Albizzia stipulata* Nagadhoolie, T. E., Coll.: V. A., 25-5-1958 (M.H.T.E.S. No. 97).

36. *Physarum reniforme* G. Lister, *A Monograph of the Mycetozoa*, 2nd ed., p. 72, 1911; Martin, G. W., *North American Flora, Fungi-Myxomycetes*, pp. 111, 126 and 127, 1949, as *Physarum nicaraguense* Macbride.

This species is rather rare here. Plasmodium not observed. Sporangia often scattered, mostly stalked, reniform, compressed, obconic or lobed or bolster-shaped; about 1 mm. in diameter, clusters of 6-12 sporangia are often seen presenting the typical gyrose aspect so characteristic of *Physarum gyrosum*. Peridium membranous with clustered deposits of densely packed lime-granules. Stalk distinct,



TEXT-FIGS. 119-3. *Physarum compressum* Alb. and Schw. (M.H.T.E.S. No. 92). Fig. 119. Fructifications on decaying twigs. Fig. 120. Sporangia showing the well-developed striate stipe and the dehiscence along the top narrow edge. Fig. 121. Stipe bearing the persistent base of the peridium at the apex. Fig. 122. Calcareous knots and non-calcareous internodes. Fig. 123. Spores.

slender, varying in colour from yellowish brown to deep fuscous, rather weak, measuring up to 1 mm. in length, enclosing abundantly refuse matter and arising from a well-developed hypothallus. Capillitium consists of a dense network of lime knots interconnected by thin or thick, hyaline threads. No pseudocolumella was observed in any of the specimens collected. Spores deep brownish-black in transmitted light, spherical, measuring $9-12(-14)\mu$ in diameter, beset with distinct spinules.

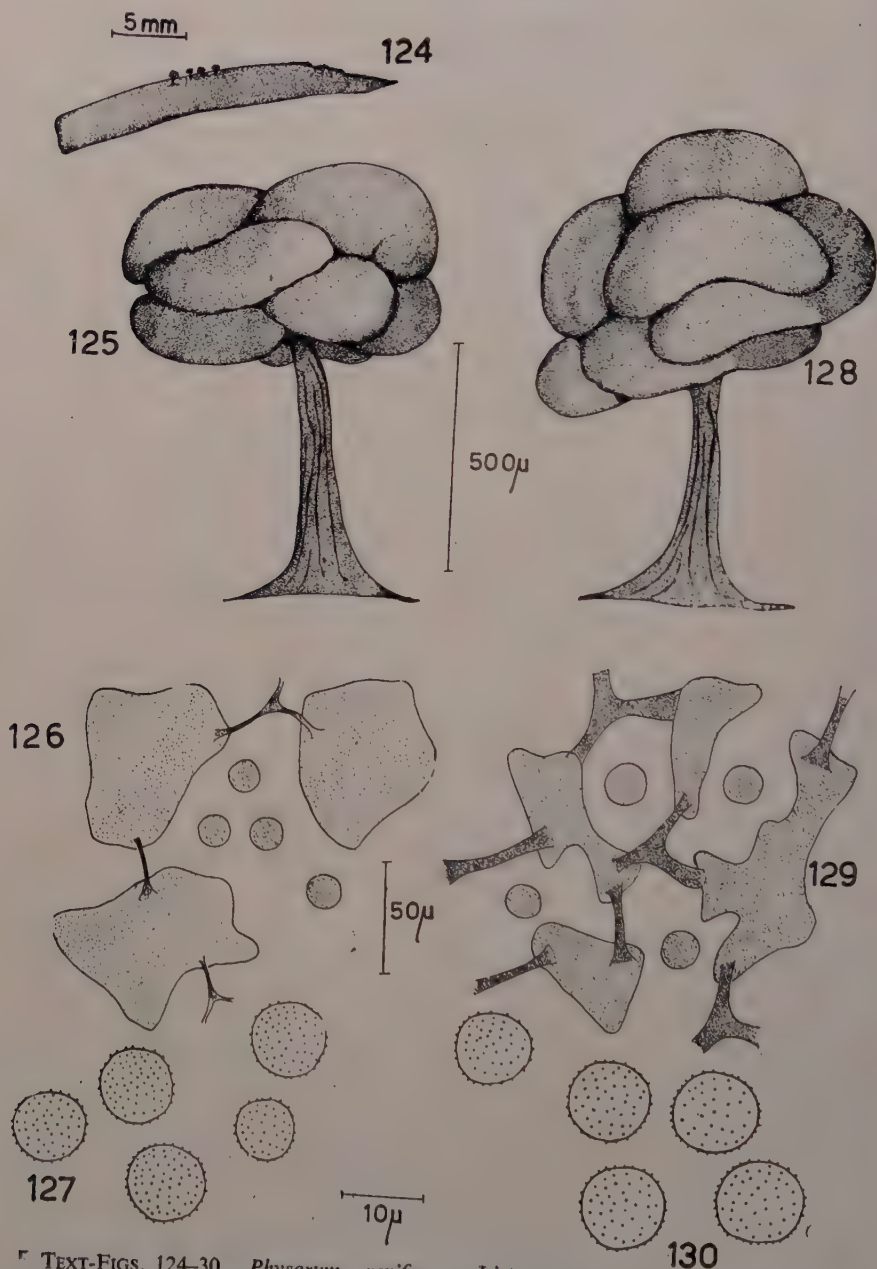
Two distinctly different forms are collected here, although they are apparently alike, one is characterized by smaller spores $9-10(-11)\mu$ and the other $9-12(-14)\mu$, both showing distinct, prominent spinescent ornamentations on the spore wall.

The capillitium in one collection has larger, irregularly shaped, calcareous knots, interconnected by slender, hyaline threads (Text-Figs. 124-27), whereas the other has badhamoid capillitium including smaller calcareous nodes (Text-Figs. 128-30). The slender, often straggling stalk of the sporangia and the general aspect of the fruit-body bears superficial resemblance to *Physarum compressum* but on careful examination the species could be readily distinguished from the latter in the presence of typical bolster-shaped clusters of sporangia containing bigger, spinulose spores. Lister's (1925) description of the spores with spinules arranged in distinct facets could not be confirmed in the local collections. This species has been treated as a synonym of *Physarum nicaraguense* Macbride by Martin (1949).

On decaying bark of *Albizia stipulata* Boiv., Borbhetta experimental plots, Coll.: V. A., 1-2-1957 (M.H.T.E.S. No. 98); on decaying wood of an undetermined host, Tocklai, Coll.: V. A., 19-6-1957 (M.H.T.E.S. No. 99); on bark of a tea bush infected by branch canker (*Poria* sp.) Tocklai, Coll.: V. A., 17-8-1958 (M.H.T.E.S. No. 101); on decaying leaves of *Musa paradisiaca* L., Jorhat, Coll.: V. A., 10-3-1957 (M.H.T.E.S. No. 102).

37. *Physarum bogoriense* Raciborski in *Hedwigia*, 37, p. 52, 1898; Lister, A., *A Monograph of the Mycetozoa*, pp. 58-59, 1925; Martin, G. W., *North American Flora, Fungi-Myxomycetes*, p. 109, 1949.

This is a fairly common myxomycete occurring during the rainy season on various grass hosts. The plasmodium is watery-white to pale yellowish in colour. Sporangia, scattered, globose, typically sessile, often united to form somewhat angular, flexuose plasmodiocarps which are never reticulate, measuring up to 0.5 mm. in diameter, varying in colour from white to ash-grey; sporangial peridium double; the outer wall smooth, whitish on the inner side, densely charged with lime granules. The outer layer of the peridium is areolate with paler lines all over the surface along which the peridium ruptures and the broken away peridial flaps remain reflexed, exposing an inner thin membranous peridial layer which is colourless and prominently iridescent. Capillitium abundant and consists of large, white lime knots



TEXT-FIGS. 124-30. *Physarum reniforme* Lister. Figs. 124-27. (M.H.T.E.S. No. 89). Figs. 128-30. (M.H.T.E.S. No. 102). Fig. 124. Fructifications on decaying bark. Figs. 125 and 128. Fructifications with longitudinally striate stipes and the well-formed hypothallus. Figs. 126 and 129. Capillitium and calcareous nodules. Figs. 127 and 130. Spores.

of diverse sizes and shapes, connected by thin, slender, hyaline threads; spores deep purplish-black in mass, rather lilac brown individually in transmitted light, spherical, almost smooth, measuring $7-8\mu$ in diameter (Text-Figs. 131-38).

This species is very similar to *Physarum sinuosum* Weinm. ex Fr., in appearance but differs in the mode of dehiscence which is by more or less reflexed peridial lobes. *P. sinuosum* opens by a slit along the upper narrow edge of the plasmodiocarp, as in *P. compressum*.

On living leaves and stems of *Setaria* sp., Tocklai, Coll.: V. A., 15-5-1957 (M.H.T.E.S. No. 103); on leaves of *Areca catechu* L., Nazira, Coll.: G. C. S. B., 12-6-1957 (M.H.T.E.S. No. 104); on living leaves of *Acalypha indica* L., Murmuria, Coll.: V. A., 18-6-1957 (M.H.T.E.S. No. 106); on leaves and culms of an unidentified grass, Hatichungh, T. E., Coll.: V. A. and G. C. S. B., 17-7-1957 (M.H.T.E.S. No. 107); on leaves of *Musa paradisiaca* L., Nazira, Coll.: G. C. S. B., 15-8-1957 (M.H.T.E.S. No. 108); on undetermined leaves, Titabar, Coll.: V. A., 1-1-1958 (M.H.T.E.S. No. 109); on leaves of *Cocos nucifera* L., Jorhat, Coll.: V. A., 10-9-1958, (M.H.T.E.S. No. 110).

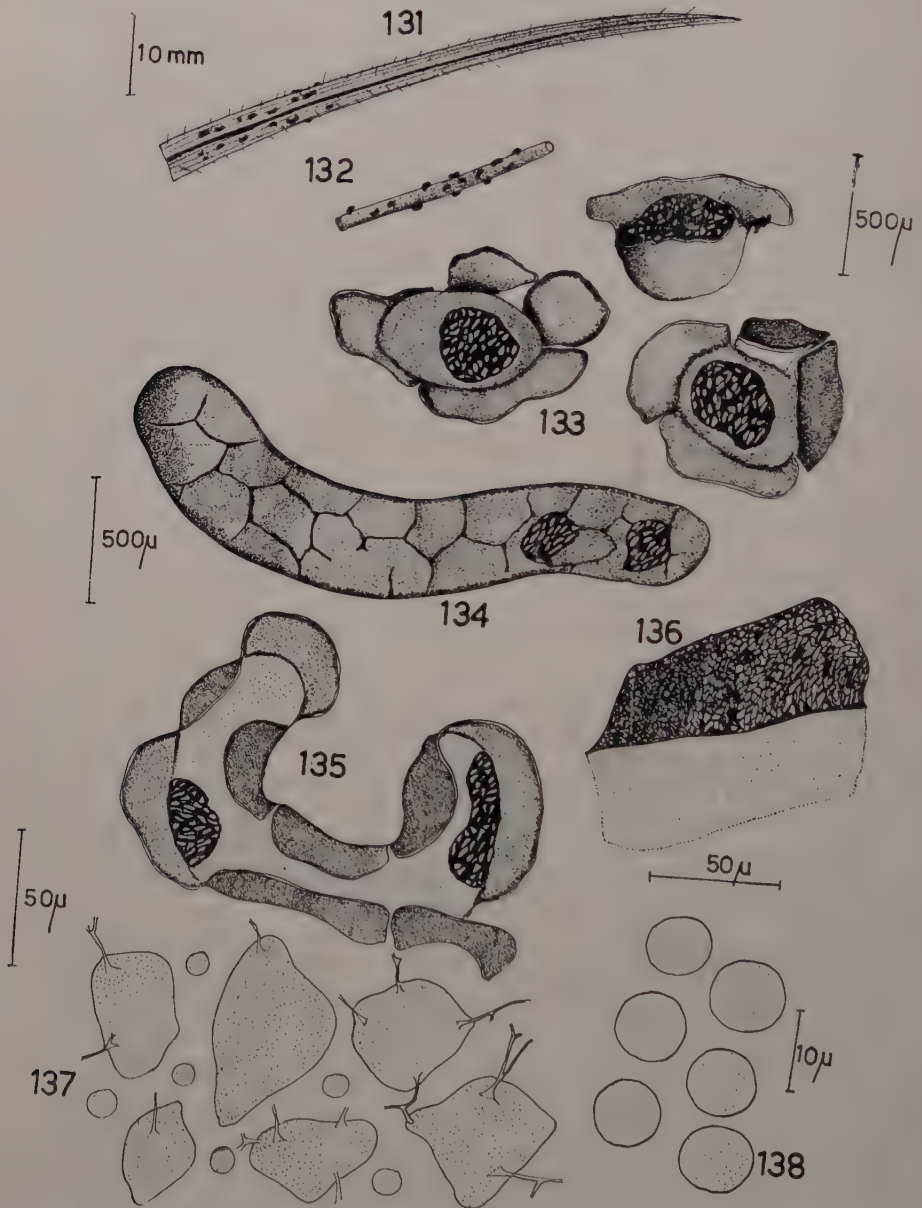
38. *Physarum roseum* Berkeley and Broome, *J. Linn. Soc.*, **14**, p. 84, 1873; Lister, A., *A Monograph of the Mycetozoa*, p. 33, 1925; Martin, G. W., *North American Flora, Fungi-Myxomycetes*, p. 118, 1949.

Plasmodium not observed. Fructifications typically sporangiate, measuring up to 1 mm. in height. Sporangia globose, measuring up to 0.5 mm. in diameter, stalked, subgregarious, rather umbilicate at the base; peridium membranous, bright red in colour, almost smooth, gorged with clusters of purplish-red lime granules; stalks slender, subulate, deep reddish-brown, opaque, longitudinally striate, narrow towards the sporangial end, broad towards the base, arising from a well-formed membranous hypothallus which may be confluent. Stalk is free from lime and the sporangium is devoid of a columella. Capillitium lax, composed of pale, lilac, threads interconnecting a few large irregularly branched purple-red lime knots. Spores deep purple-black in mass, pale lilac-brown individually in transmitted light, spherical, minutely spinulose, measuring $7-9(-10)\mu$ in diameter. (Text-Figs. 139-43).

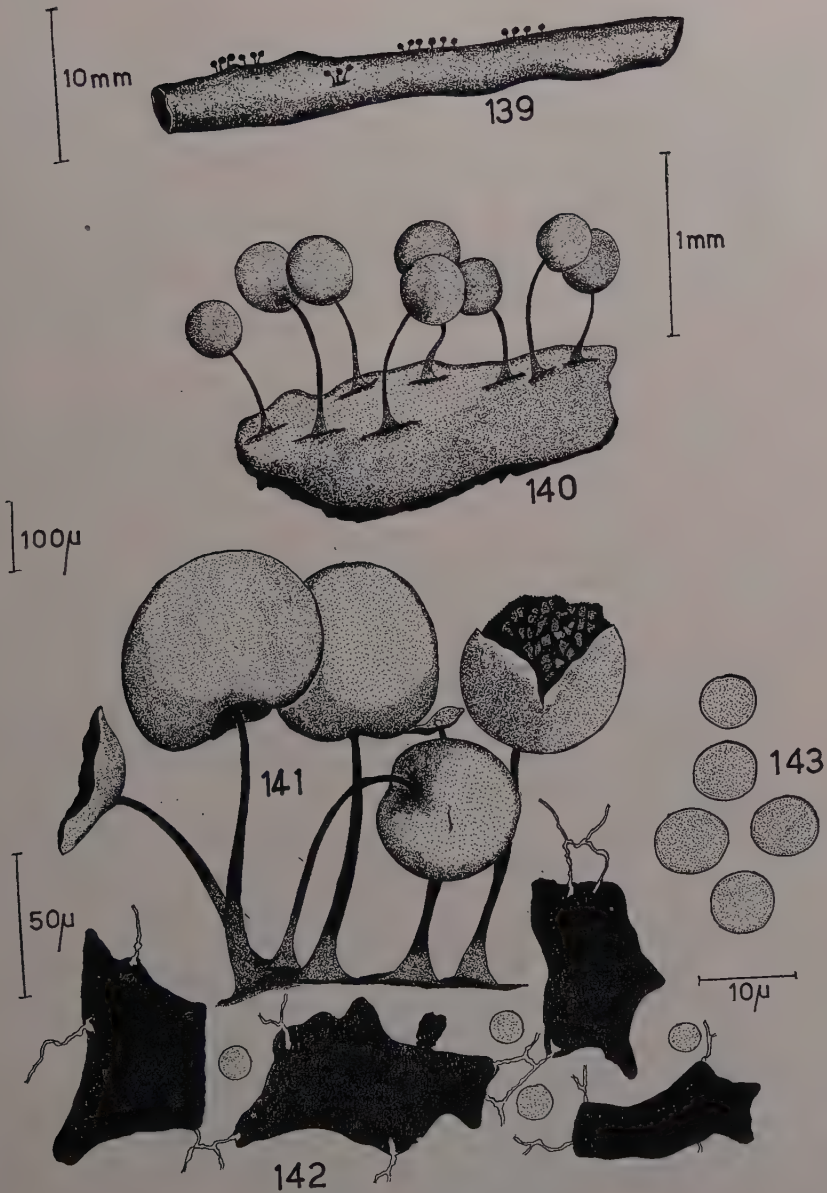
P. roseum bears striking similarity to *Physarum pulcherrimum* Berkeley and Broome, but the stipes in *P. roseum* are translucent and free from lime and the calcareous knots of the capillitial reticulum are much larger, angular and irregularly branched.

Only one collection was made: on dead twigs of *Enterolobium saman* Prain, Tocklai, Coll.: Mr. K. C. Barua, 15-5-1958 (M.H.T.E.S. No. 111).

39. *Physarum leucopus* Link in *Ges. Nat. Freunde Berlin Mag.*, **3**, p. 27, 1809; Lister, A., *A Monograph of the Mycetozoa*,



TEXT-FIGS. 131-38. *Physarum bogoriense* Raciborski (M.H.T.E.S. No. 103). Figs. 131-32. Sporangia on leaf and stem of *Setaria* sp. Fig. 133. Sporangia showing the dehiscent outer peridium and inner membranous peridial layer. Fig. 134. A plasmodiocarp showing areolations. Fig. 135. A dehiscent plasmodiocarp with persistent reflexed outer peridium and the inner membranous wall. Fig. 136. Peridial walls, the outer wall with heavily charged lime granules and the inner membranous layer. Fig. 137. Capillitial nodes and internodes. Fig. 138. Spores.



TEXT-FIGS. 139-43. *Physarum roseum* Berk. and Broome (M.H.T.E.S. No. 111). Figs. 139-40. Sporangia on a decaying twig. Fig. 141. Sporangia showing the stipe and irregular dehiscence of the peridium. Fig. 142. Calcareous nodes and non-calcareous internodes of the capillitium. Fig. 143. Spores.

pp. 24-25, 1925; Martin, G. W., *North American Flora, Fungi-Myxomycetes*, pp. 116-17, 1949.

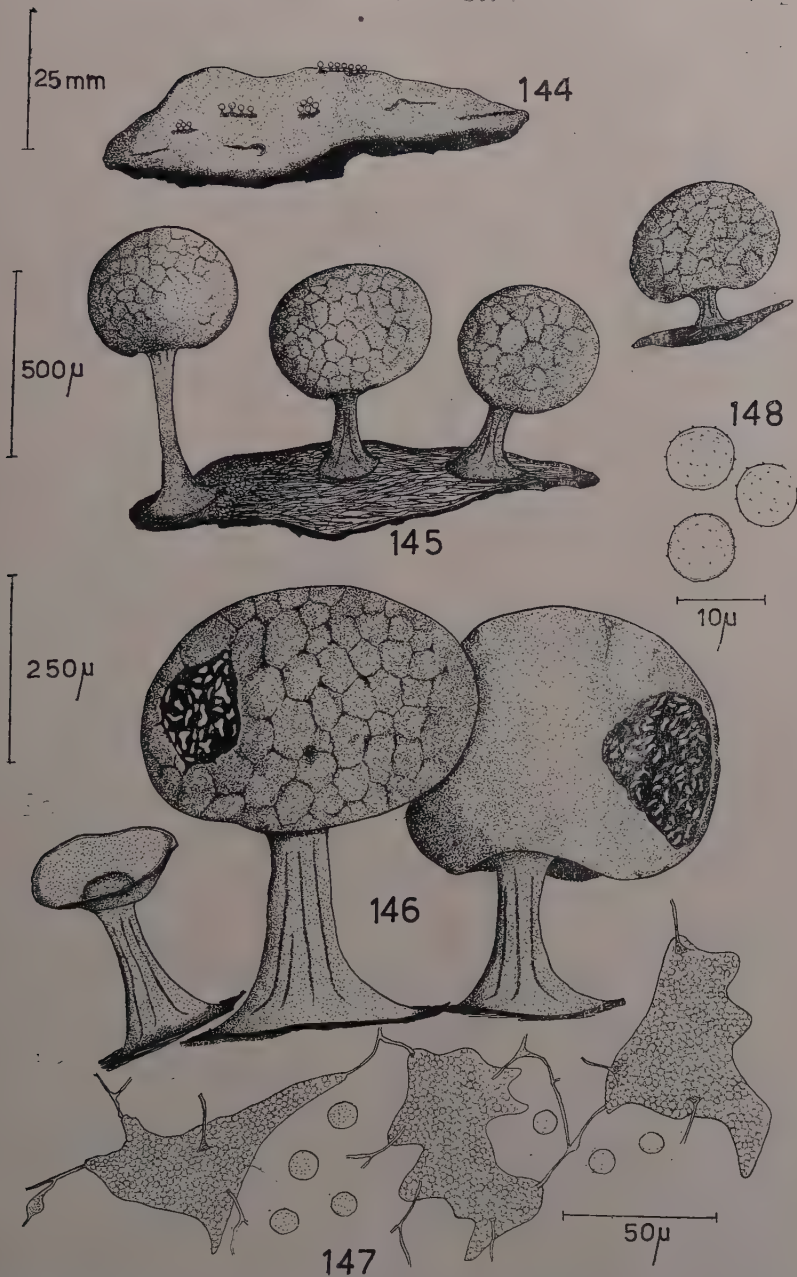
Plasmodium not observed. The total height of the sporangia is about 1 mm. Sporangial head globose to spherical or subglobose, white with slight greyish hue or almost glaucous, about 0.5 mm. in diameter. Sporangia are loosely aggregated on the substratum, stalked; peridium membranous, containing scattered or clustered deposits of calcareous granules; stalks white, or greyish-white, about 0.1 mm. thick and 0.5 mm. long, longitudinally furrowed, erect, rigid, brittle, somewhat tapering above, densely packed with lime granules, arising from a more or less well-developed hypothallus. Columella none; capillitium consisting of delicate, branching, hyaline threads connecting irregular, large, white calcareous nodules; spores black in mass, pale violaceous in transmitted light; spherical, distinctly warted, measuring 7-9 (-10) μ in diameter (Text-Figs. 144-48).

This species bears certain superficial resemblance to *Physarum nutans* Persoon but sharply differs from the latter in possessing stouter stipes. *P. nutans* generally has thin, subulate stalks which contain dark refuse matter and the sporangia are more often nodding than not.

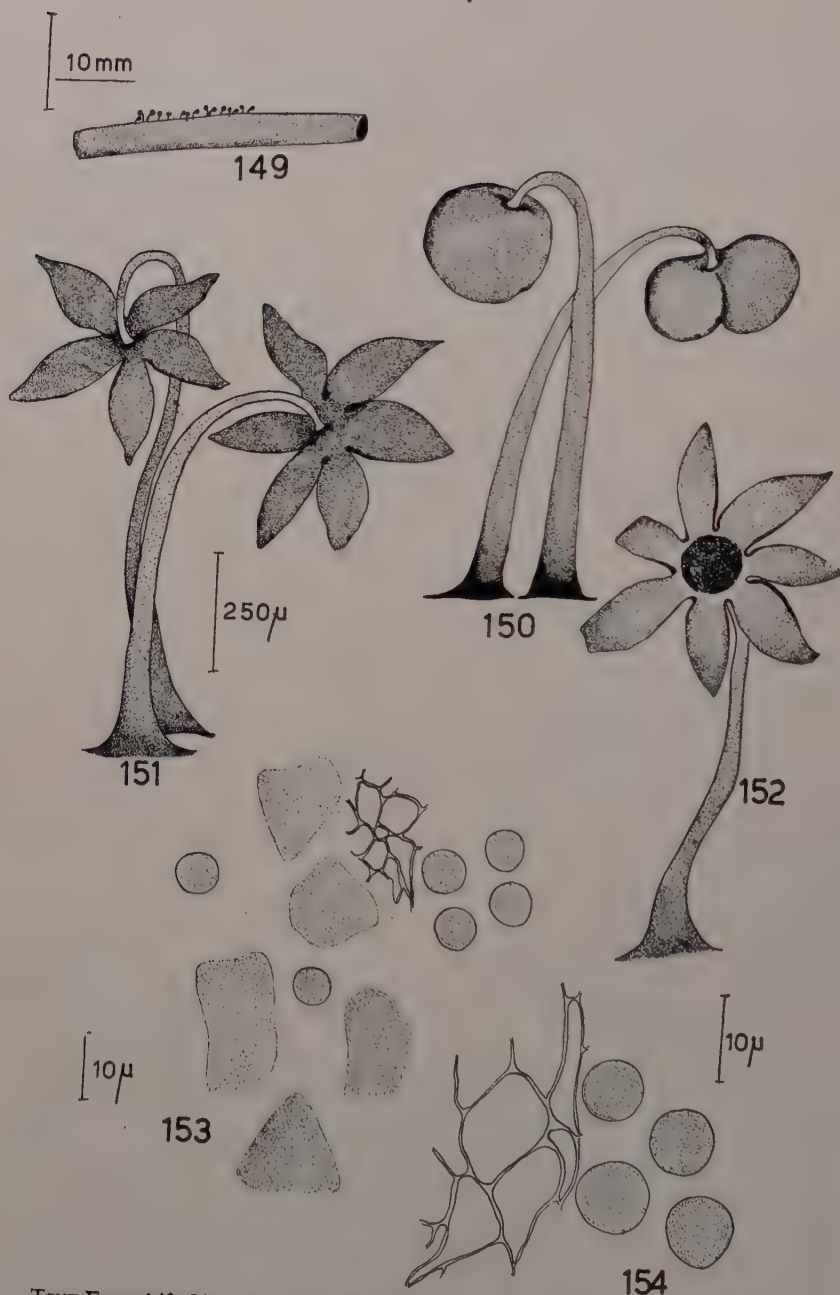
Only one collection of this myxomycete is preserved: on decaying twigs of *Mallotus albus* M. Arg., Tocklai, Coll.: H. K. P., 26-5-1958 (M.H.T.E.S. No. 112).

40. *Physarum nucleatum* Rex in *Proc. Acad. Sci. Phila.*, p. 389, 1891; Lister, A., *A Monograph of the Mycetozoa*, pp. 43-44, 1925; Martin, G. W., *North American Flora, Fungi-Myxomycetes*, pp. 115-16, 1949; Thind, K. S. and Sohi, H. S., *Indian Phytopathology*, 8, p. 155, 1955.

Plasmodium not observed. Total height of the sporangia up to 2.0 mm.; sporangial head globose or spherical, somewhat gregarious, stalked, erect, or slightly nodding, about 0.5 mm. in diameter, white, turning slightly dirty-white when old. No plasmodiocarpous or sessile forms were observed. Sporangial wall membranous, densely charged with rounded, white lime granules. Peridium breaks irregularly and longitudinally so that in a dehiscent sporangium the remnants of the peridial wall appear petaloid. In some sporangia the peridium is entirely fugacious except at the base when it forms a collar at the apex of the stipe. Stalk long, up to 1.5 mm., subulate, pale yellowish-white, rugose, furrowed longitudinally, translucent above without any deposits of lime, enclosing refuse matter and arising from a more or less well developed hypothallus. Capillitium abundant, a close network of very slender, colourless threads interconnecting large, white, rounded calcareous nodes; in the centre of the capillitial mass is a dense aggregation of lime knots forming a pseudocolumella; spores deeply fuliginous in mass, almost pale brownish lilac, in transmitted light, minutely verrucose, measuring, 5-6 (-7) μ in diameter (Text-Figs. 149-54).



TEXT-FIGS. 144-48. *Physarum leucopus* Link (M.H.T.E.S. No. 112). Figs. 144-45. Sporangia on bark of decaying twigs. Fig. 146. A sporangial group showing the areolate and rugose peridial walls. Fig. 147. Capillitium with calcarous nodes. Fig. 148. Spores.



TEXT-FIGS. 149-54. *Physarum nucleatum* Rex (M.H.T.E.S. No. 114). Fig. 149. Sporangia on the mid-rib of a fern frond. Fig. 150. Two nodding sporangia with the peridium intact. Fig. 151. Two sporangia with the peridium dehiscent and remaining attached to the stipe in a petaloid fashion. Fig. 152. Dehiscent sporangium showing the pseudocolumella. Fig. 153. Calcareous knots and non-calcareous internodes of the capillitium. Fig. 154. Spores.

Only two specimens of this myxomycete were collected: one on the decaying leaf-sheaths of *Musa paradisiaca* L., Jorhat, Coll.: H. K. P., 12-8-1958 (M.H.T.E.S. No. 113); and the other on fronds of *Pteris* sp., Nazira, Coll.: G. C. S. B., 15-8-1957 (M.H.T.E.S. No. 114).

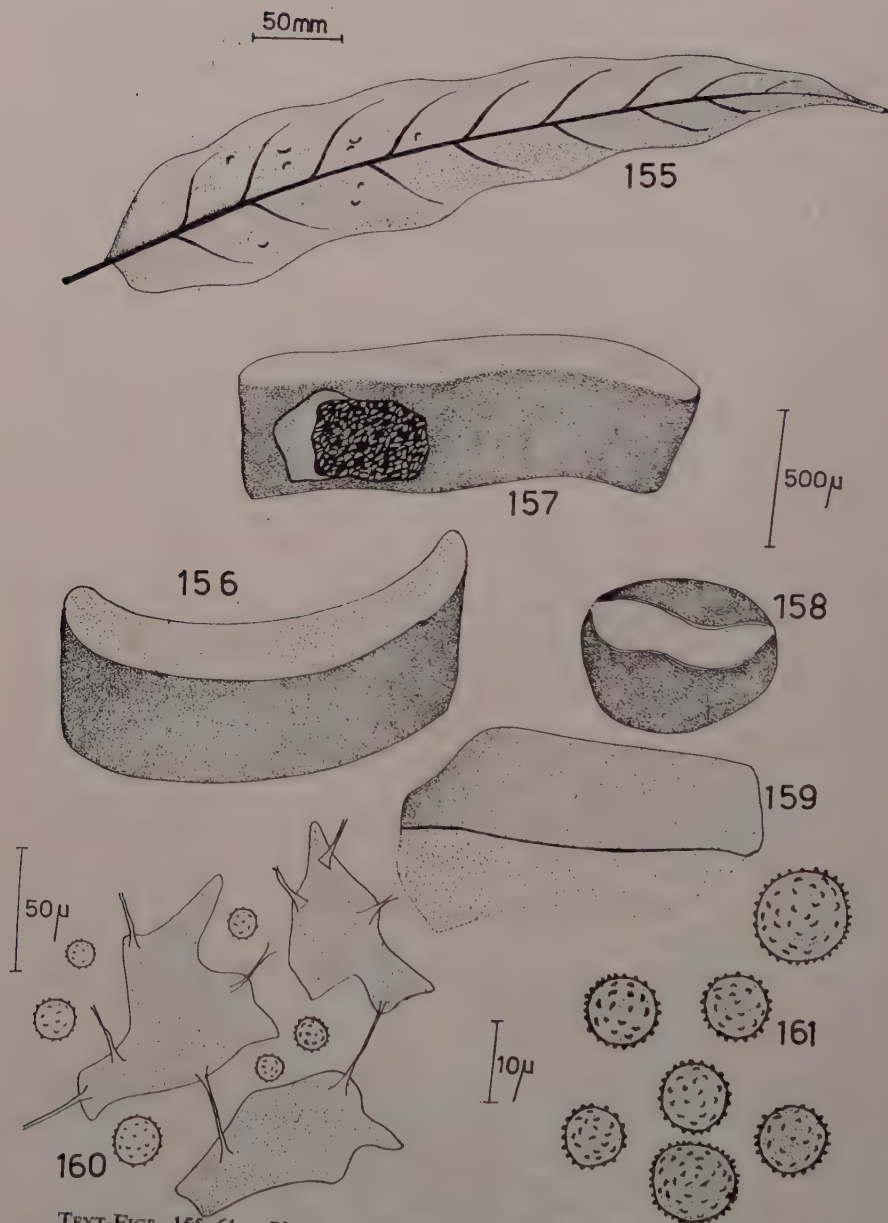
41. *Physarum serpula* Morgan in *J. Cinc. Soc. Nat. Hist.*, **19**, p. 29, 1896; Lister, A., *A Monograph of the Mycetozoa*, pp. 61-62, 1925; Martin, G. W., *North American Flora, Fungi-Myxomycetes*, p. 108, 1949; Agnihothrudu, V., *J. Indian bot. Soc.*, **34**, pp. 87-88, 1955.

This species appears to be rather rare locally. The collected specimens agree in all respects with the species reported by the writer from Madras (*loc. cit.*). It is sufficiently distinctive in appearance, particularly the colour of the peridium which is greenish-yellow when fresh. The sporangial wall is membranous, mottled with dense aggregations of yellowish lime granules. The calcareous knots comprising the capillitium are also yellowish in colour. The sporangia generally, are globose to subglobose or slightly elongate, sinuous, forming short plasmodiocarps without showing any tendency towards the formation of a stalk. In these features this species differs sharply from *Physarum sulphureum* described elsewhere in this article. In the local forms the plasmodiocarps are short although net-like fructifications were encountered in the South Indian collection. As compared with the plasmodiocarpous forms of *P. sulphureum*, the plasmodiocarps of *P. serpula* are rather narrower, longer, more sinuous and generally net-like or ring-shaped. The lime knots are much smaller and denser with very short connecting hyaline non-calcareous internodes. The spores are larger than in *Physarum sulphureum* in being mostly 10-12 μ in diameter.

Only one collection is preserved: on decaying bark of *Hibiscus rosa-sinensis* L., Tocklai, Coll.: Mr. W. Hadfield, 14-6-1958 (M.H.T.E.S. No. 176).

42. *Physarum echinosporum* Lister, A. in *J. Bot.*, **37**, p. 147, 1899; Lister, A., *A Monograph of the Mycetozoa*, pp. 57-58, 1925; Martin, G. W., *North American Flora, Fungi-Myxomycetes*, p. 108, 1949; Agnihothrudu, V., *J. Indian bot. Soc.*, **34**, pp. 88-90, 1955; Thind, K. S. and Rehill, P. S., *Indian Phytopathology*, pp. 93-94, 1957.

This typically laterally compressed species of *Physarum* occurs on vegetable debris during the rainy months. The general appearance of the plasmodiocarps agrees with those reported from Madras by the writer (*loc. cit.*). There is considerable variation, however, in the spore size of forms occurring locally. In the one reported from Madras the spores on average measured 7.9 μ , the range in diameter being 7.8-8.6 μ as compared with the local form in which the spores are 10-12 (-14) μ . Spores are deep purplish-brown, marked with heavy ridges and blunt cogs which are strikingly prominent (Text-Figs. 155-161).



TEXT-FIGS. 155-61. *Physarum echinosporum* Lister (M.H.T.E.S. No. 121). Fig. 155. Plasmodiocarps on a decaying leaf. Fig. 156. A Plasmodiocarp with the peridium intact. Fig. 157. Plasmodiocarps showing the inner thin membranous peridium and calcareous knots of the capillitium. Fig. 158. A sporangium with widely gaping outer peridium exposing the intact inner peridial wall. Fig. 159. The outer and inner peridial walls. Fig. 160. Capillitium with lime knots and hyaline internodes. Fig. 161. Spores.

Thind and Rehill (*loc. cit.*) reported imperfect reticulations on the surface of the spores which feature, however, has not been observed either in the form occurring locally or those reported from Madras (Agnihothrudu, 1955). While the form collected in the South agrees very closely with the description given by Lister (1925), the local species has morphological characters, particularly the spore dimensions which are more in keeping with Boedijn's (1940) description rather than that of Lister (*loc. cit.*).

Only one collection is preserved: on decaying leaves of *Mangifera indica* L., Jorhat, Coll.: H. K. P., 12-8-1957 (M.H.T.E.S. No. 121).

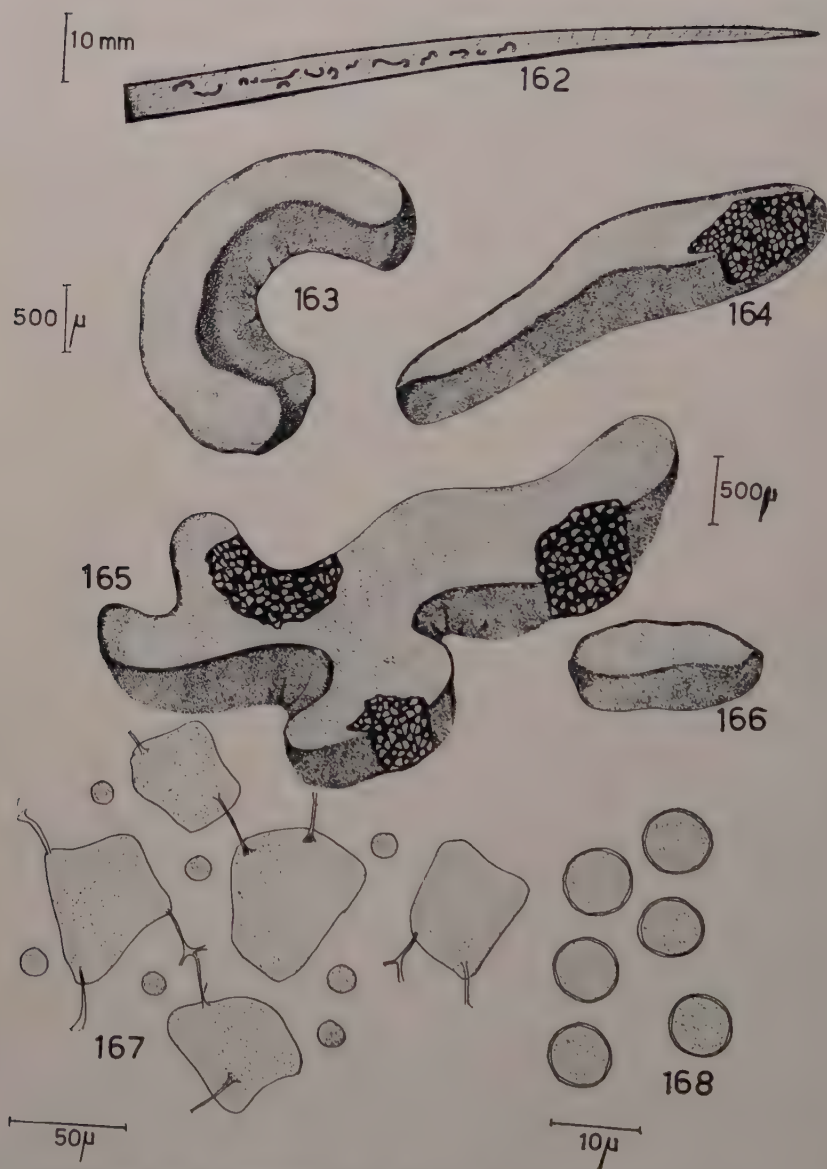
43. *Physarum sessile* Brândză in *Ann. Sci. Univ. Jassy*, **11**, p. 116, 1921; Lister, A., *A Monograph of the Mycetozoa*, pp. 55-56, 1925; Martin, G. W., *North American Flora, Fungi-Myxomycetes*, p. 126, 1949.

Plasmodium not observed. Sporangia typically sessile; globose to subglobose or forming plasmodiocarps which are simple and sparingly branched, rather rugose, somewhat compressed, varying in colour from dirty-white to pale yellowish-white; about 0.5 mm. in diameter; sporangial wall membranous, egg-shell-like, charged densely with small rounded calcareous granules; breaking away irregularly exposing the spore mass and the capillitium. Capillitium consisting of numerous white calcareous knots, rounded, angular, of diverse shapes and sizes, interconnected by short hyaline, non-calcareous threads. Spores pale brownish lilac in transmitted light, measuring 7-9 (-10) μ in diameter, spherical, with smooth walls (Text-Figs. 162-68).

Known to the students of Mycetozoa as *Physarum variabile* Rex var. *sessile* Lister, this variety has been elevated to specific rank by Miss Lister in her third edition of the *Monograph* (1925). *P. variabile* has been considered as a phase of *Physarum sulphureum* Alb. and Schw., accepting *P. sessile* Brândză as a separate species. It should, however, be mentioned here that *Physarum sulphureum* has generally been regarded as a stipitate form although plasmodiocarpous members of this species have been reported elsewhere.

On decaying leaves of *Musa paradisiaca* L., Tocklai, Coll.: H. K. P., 14-6-1957 (M.H.T.E.S. No. 115); on leaves of an undetermined host, Nazira, Coll.: G. C. S. B., 15-8-1957 (M.H.T.E.S. No. 116); on leaf-sheaths of an undetermined Scitamineae, Nazira, Coll.: G. C. S. B., 15-8-1957 (M.H.T.E.S. No. 117); on leaves and culms of a reed grass Jorhat, Coll.: H. K. P., 24-6-1958 (M.H.T.E.S. No. 118); on decaying leaves of *Cocos nucifera* L., Jorhat, Coll.: V. A., 3-4-1958 (M.H.T.E.S. No. 119); on leaves of *Saccharum spontaneum* L., Nagajanka, T. E., Coll.: V. A., 12-5-1958 (M.H.T.E.S. No. 120).

44. *Craterium leucocephalum* (Persoon) Ditmar in *Die Pilze Deutschlands in Sturm, Deutschlands Flora*, p. 21, 1813; Lister, A.,



TEXT-FIGS. 162-68. *Physarum sessile* Brândză (M.H.T.E.S. No. 118). Fig. 162. Plasmodiocarps on the leaf blade of a grass. Fig. 163. Plasmodiocarp with the peridium intact. Fig. 164. Plasmodiocarp with dehiscent peridium. Fig. 165. A somewhat sparingly branched plasmodiocarp which is flat. Fig. 166. A sporangium with peridium intact. Fig. 167. Capillitium showing the calcareous nodes and internodes.

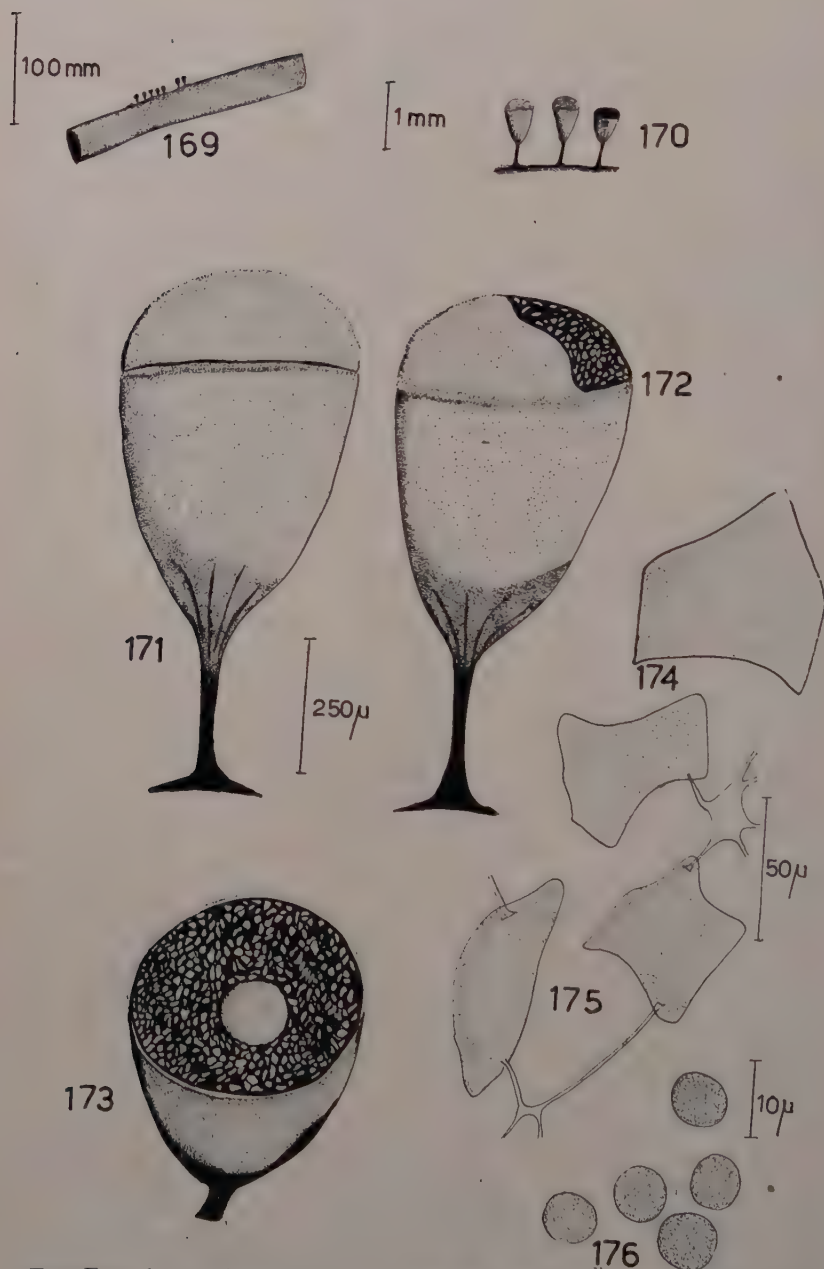
A Monograph of the Mycetoza, pp. 77–79, 1925, as *Craterium leucocephalum* Ditmar; Martin, G. W., *North American Flora, Fungi-Myxomycetes*, pp. 126–27, 1949; Thind, K. S. and Sohi, H. S., *Indian Phytopathology*, 8, pp. 155–56, 1955.

No plasmodium was observed. This species appears to be rather not very common locally. Total height of the sporangia about 1 mm. Sporangia subgregarious, ovoid or obtuse turbinate or cyathiform, typically stipitate, erect, about 0.75 mm. high and 0.5 mm. in diameter at the widest part, white above, densely charged with lime granules, showing slightly reddish-brown tinge with minute yellow warts. The sporangium dehisces in the upper part in a regular circumscissile fashion, the upper part coming away as a lid leaving the spore mass and capillitium enclosed in a bell-shaped or infundibulliform lower part of the sporangium. Sporangial wall thin, consisting of two closed united layers, the outer being rather pale yellowish with densely charged lime granules. This layer is very fragile and fugacious in the upper part of the sporangium. Peridium at the base of the sporangium somewhat cartilaginous and translucent. The inner peridial layer which could be detected with some difficulty in the local specimens is typically membranous and almost colourless. Stalk distinct, much reduced in some of the sporangia in the same collection so that the fructifications appear almost sessile to the naked eye. In most of the specimens, the stipe is well formed, cylindrical, plicate, measuring up to 0.5 mm. long, pale reddish-brown, cartilaginous, translucent, arising from a well-developed circular hypothallus which is a trifle deeper in shade than the stipe. Capillitium consisting of large calcareous nodes irregular in shape and variable in size, interconnected by non-calcareous, short, hyaline internodes. Lime knots are densely aggregated in the centre of the sporangium to form a compact mass of pseudocolumella which is white and prominent in most of the sporangia. Spores deep brownish-black in mass, pale purple-brown in transmitted light, spherical, uniformly and distinctly verrucose, measuring 7–8 (–9) μ in diameter (Text-Figs. 169–76).

Lister (1925) describes in typical members of this species yellow crystalline bodies which could be seen in sporangial wall, lime knots and pseudocolumella treated in xylol. No such crystalline disc-shaped bodies were seen in any of the sporangia under report here. The other characters of the species, however, are fairly distinct to facilitate easy identification.

On decaying leaves and twigs of *Grevillea robusta* A. Cunn., Tocklai, Coll.: H. K. P. and G. C. S. B., 20–5–1957 (M.H.T.E.S. No. 122); on leaves of tea, Tocklai, Coll.: V. A., 22–6–1957 (M.H.T.E.S. No. 123); on decaying leaves of tea, Hatichunghi, T. E., Coll.: V. A., and G. C. S. B., 4–3–1958 (M.H.T.E.S. No. 124).

45. *Craterium aureum* (Schumacher) Rostafinski in *Śluzowców (Mycetoza) Monografia*, p. 124, 1875; Lister, A., *A Monograph*



TEXT-FIGS. 169-76. *Craterium leucocephalum* (Pers.) Ditmar (M.H.T.E.S. No. 122). Fig. 169. Sporangia on a decaying twig. Fig. 170. A group of three sporangia one of which has dehisced. Fig. 171. Sporangium with stipe and peridium intact. Fig. 172. Sporangium with the peridium peeling away at the top. Fig. 173. A dehiscent sporangium showing the capillitial knots and pseudocolumella. Fig. 174. Peridial fragment. Fig. 175. Capillitium with calcareous nodules and non-calcareous internodes. Fig. 176. Spores.

of the *Mycetozoa*, pp. 79-80, 1925, as *Craterium aureum* Rostafinski; Martin, G.W., *North American Flora, Fungi-Myxomycetes*, p. 127, 1949.

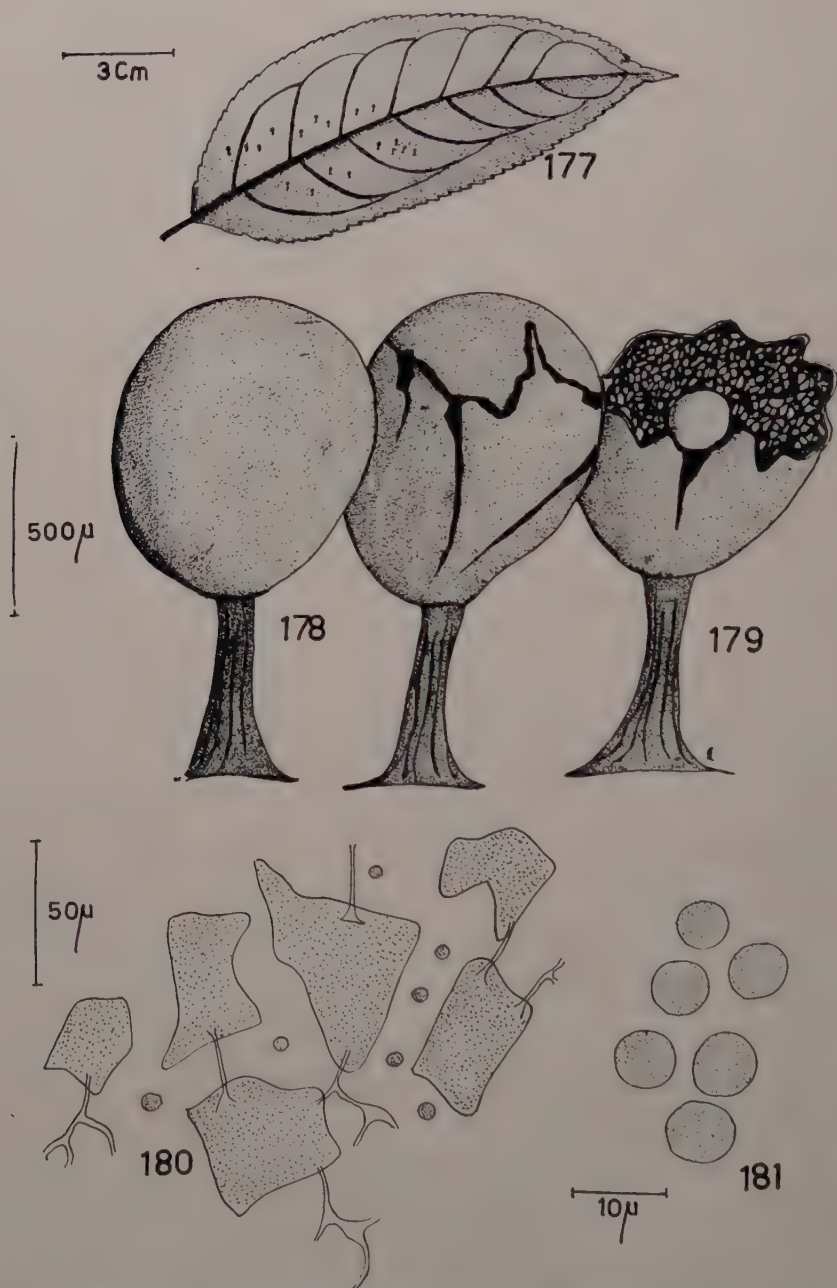
Plasmodium not observed. This species is fairly abundant on decaying vegetable debris. Total height of the sporangium up to 0.75 mm., gregarious, ovoid or obovoid to globose; stalked, erect, rugose, bright golden-yellow becoming paler and almost white with age and exposure to sunlight. The peridium dehisces in an irregular manner at the top of the sporangium, very often the lobes of the peridium are persistent and give a petaloid appearance to the sporangium. Peridial wall typically one-layered, membranous, brittle with deposits of yellow lime granules which are more crowded and brightly coloured towards the top than towards the base of the sporangium where the peridium is thick and somewhat cartilaginous in texture. Stipe cylindrical, up to 0.5 mm. long, stout, deeply furrowed, yellowish, becoming dirty white on ageing, translucent, densely compacted with calcareous granules. The stipe originates from a pale orange-coloured hypothallus which is circular. Pseudocolumella is present in some of the sporangia while it is absent from others in the same collection. Capillitium composed of large irregular, yellow or yellowish-white calcareous nodules of diverse sizes and shapes interconnected by slender, hyaline, non-calcareous threads. Spores fuliginous in mass, violaceous brown individually in transmitted light, spherical, distinctly verrucose, measuring 8-9 (-10) μ in diameter (Text-Figs. 177-81).

The collections made here bear some superficial resemblance to *Craterium leucocephalum* (Pers.) Ditmar but sharply differ from the latter in the colour of the peridial wall which is typically one-layered and persists in petaloid lobes on the top of the stipe in most of the sporangia. It should, however, be marked here that the sporangia and calcareous knots are typically golden-yellow in colour only in fresh collections, the colour fading away to white with the ageing and exposure of the sporangia to light.

On living leaves of *Eleusine ægyptiaca* Desf., Tocklai, Coll.: H. K. P. and G. C. S. B., 20-5-1957 (M.H.T.E.S. No. 130); on decaying leaves of tea found in vegetable debris, Cinnamara, T. E., Coll.: V. A., 10-7-1957 (M.H.T.E.S. No. 131); on leaves of *Musa* sp., Nazira, Coll.: G. C. S. B., 15-8-1957 (M.H.T.E.S. No. 132); on living leaves of tea, Tocklai, Coll.: V. A., 3-7-1958 (M.H.T.E.S. No. 133); on decaying leaves of tea, Borbhetta experimental plots, Coll.: V. A., 4-9-1958 (M.H.T.E.S. No. 134).

46. *Craterium minutum* (Leers) Fries in *Syst. Myc.*, 3, p. 151, 1829; Lister, A., *A Monograph of the Mycetozoa*, pp. 75-76, 1925, as *Craterium minutum* Fries; Martin, G. W., *North American Flora, Fungi-Myxomycetes*, pp. 127-28, 1949.

Plasmodium not observed. Total height of the sporangium up to 1.5 mm. Sporangia gregarious, typically stalked. No sessile forms were encountered. Sporangium proper cyathiform or goblet-shaped,



TEXT-FIGS. 177-81. *Craterium aureum* (Schum.) Rost. (M.H.T.E.S. No. 131). Fig. 177. Sporangia on decaying tea leaf. Fig. 178. A group of two sporangia, one with the peridium intact and the other showing the irregular rupture of the peridium. Fig. 179. A completely dehiscent sporangium showing the calcareous knots and the pseudocolumella. Fig. 180. Capillitium with calcareous nodes and non-calcareous internodes. Fig. 181. Spores.

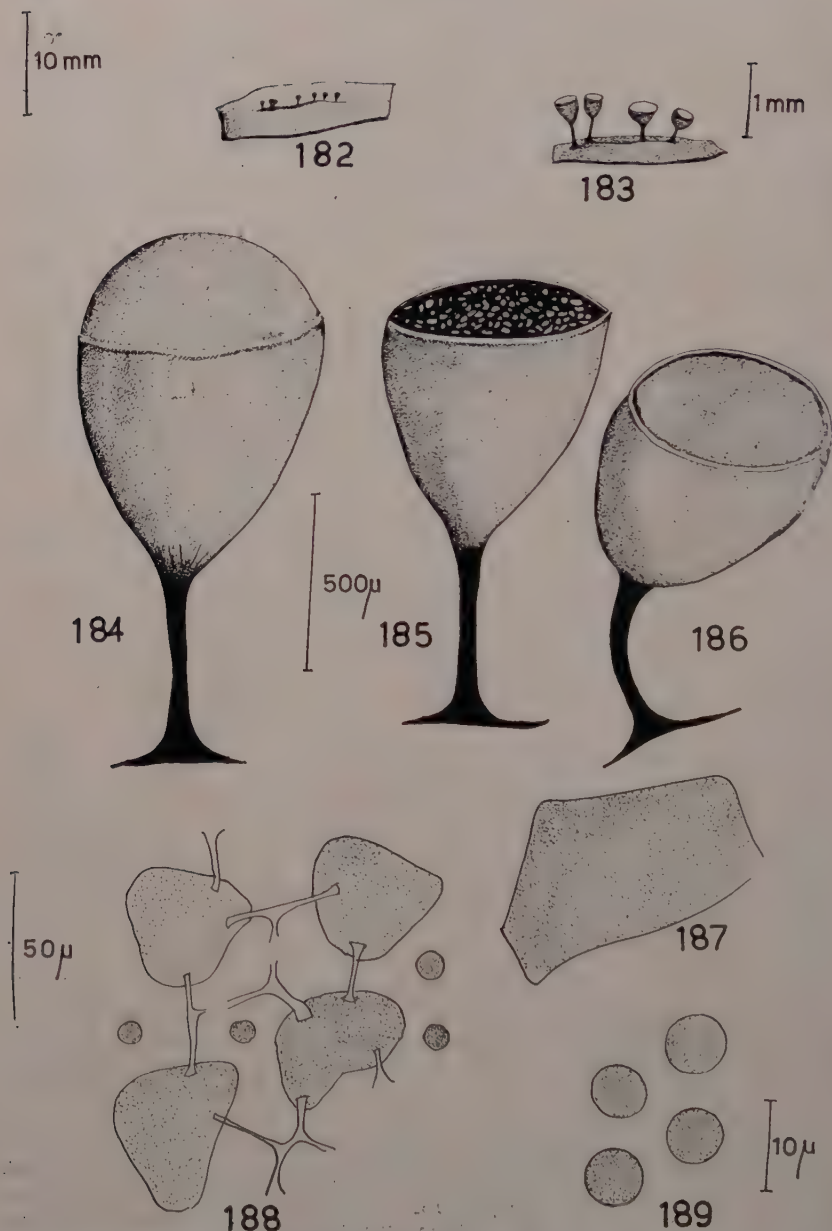
ochraceous brown to pale chocolate-brown, usually darker below; peridium consisting of two distinct layers, the outer thicker and cartilaginous, rather glaucous and free from lime, the inner layer densely impregnated with lime and varying from membranous to subcartilaginous. The peridium at the top of the sporangium has slightly bulging margin marking the line of circumscissile dehiscence. This predetermined lid, in some has been observed to be slightly convex and protruding from the sporangial wall while in others it is more or less flat or even slightly depressed. The colour of the lid is a trifle paler than the peridium. Stalk cylindrical, paler at the base of the cup, reddish-brown above, translucent, furrowed, measuring up to 0.5 mm. in height; arising from a well-developed hypothallus which is membranous and discoid. Capillitium abundant, typically physaroid consisting of large calcareous nodes which are white and interconnected with hyaline, non-calcareous threads. There is a very incipient pseudocolumella. Spores deep fuliginous in mass, pale violaceous brown in transmitted light, minutely but distinctly warted, spherical, measuring 7-9 (-10) μ in diameter (Text-Figs. 182-89).

This species is not very common locally. It is easily recognized by the typically goblet-shaped or cyathiform sporangia with distinct preformed lids which may be convex or depressed. The collections made here are different from the description of the typical species in showing no tendency towards dense aggregation of calcareous knots in the middle of the sporangium to form a pseudocolumella.

On undetermined leaves found in decaying vegetable litter, Jorhat, Coll.: G. C. S. B., 10-4-1957 (M.H.T.E.S. No. 125); on decaying leaves of an undetermined host, Jorhat, Coll.: H. K. P., 20-4-1957 (M.H.T.E.S. No. 126); on leaves of *Grevillea robusta* A. Cunn., Coll.: H. K. P. and G. C. S. B., 20-5-1957 (M.H.T.E.S. No. 127); on leaves of *Mesua ferrea* L., Tyroon, T. E., Coll.: V. A., 12-2-1957 (M.H.T.E.S. No. 128); on an undetermined leaf, Tocklai, Coll.: V. A., 6-6-1957 (M.H.T.E.S. No. 129).

47. *Physarella oblonga* (Berkeley and Curtis) Morgan in *J. Cinc. Soc. Nat. Hist.*, 19, p. 7, 1896; Lister, A., *A Monograph of the Mycetozoa*, pp. 72-73, as *Physarella oblonga* Morgan; Martin, G. W., *North American Flora, Fungi-Myxomycetes*, pp. 128-29, 1949.

This myxomycete is fairly abundant in the neighbourhood. Plasmodium rich yellow and in several cases extending over several centimeters. Total height of the sporangia range from 0.5 to 3 mm. Sporangia are typically gregarious, stalked or almost sessile in some collections, cylindric annulate or deeply umbilicate so that they present the appearance of a thimble or bell; very often the sporangia are of the nodding type measuring, 0.75 by 0.5 mm. In some instances the sporangia were found to be nearly 1 mm. or so in diameter. Sporangia are olive-yellow or slightly tinged green with flecks of brown, red or



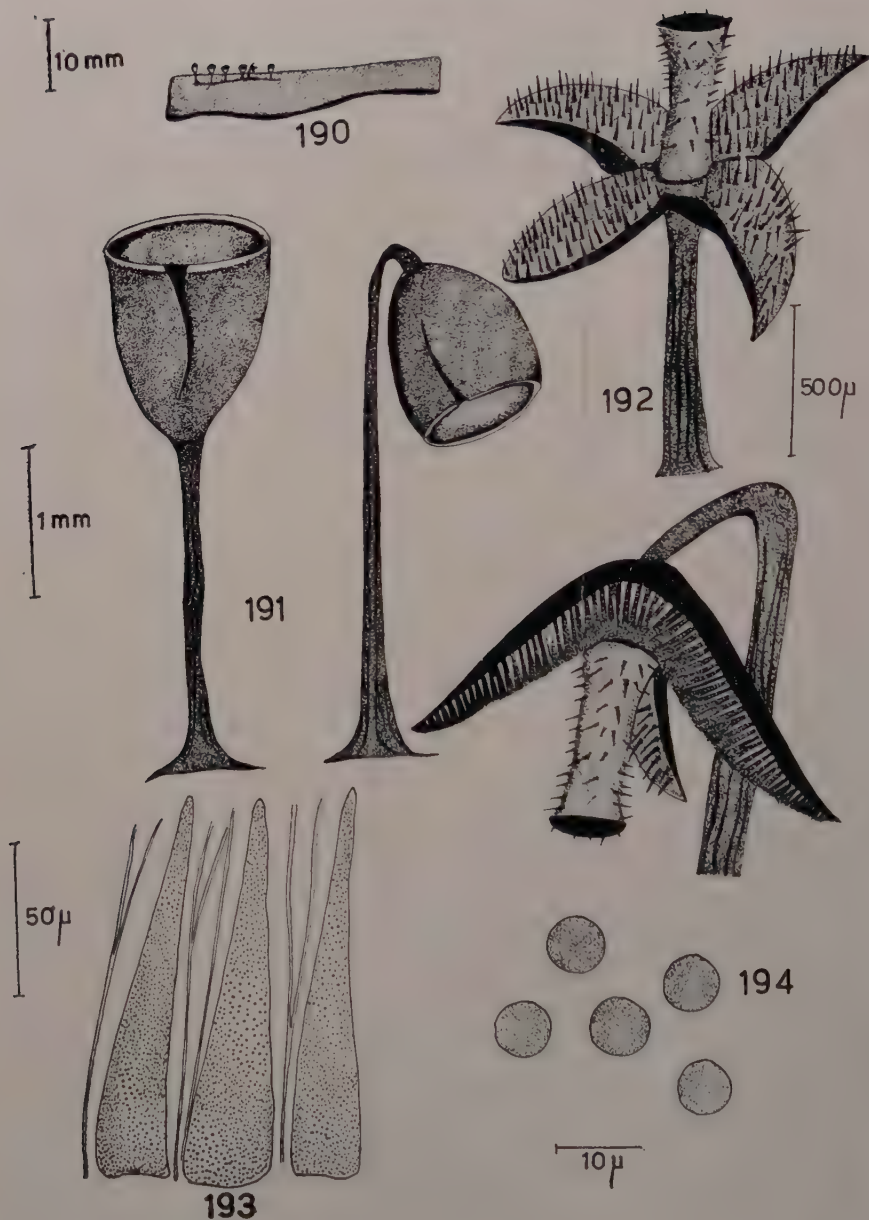
TEXT-FIGS. 182-89. *Craterium minutum* (Leers) Fr. (M.H.T.E.S. No. 128). Figs. 182-83. Sporangia on leaf fragments. Fig. 184. A sporangium with hypothallus and stipe. The peridium at the top shows the predetermined line of circumscissile dehiscence. Fig. 185. A dehiscent sporangium. Fig. 186. A sporangium with a flat depressed lid. Fig. 187. A peridial fragment. Fig. 188. Capillitium showing the lime knots and hyaline threads. Fig. 189. Spores.

yellowish scales. The deep umbilicus is generally continued into the stalk which is hollow; abnormal growths have been observed where the sporangia are irregularly expanded; peridium membranous, predominantly yellowish in most of the collections with dense deposits of lime granules of the same colour, at length dehiscing in a petaloid fashion, the dehiscent components of the peridial wall become reflexed from the wall of the deep umbilicus which persists in the form of a hollow, yellowish-brown, trumpet-shaped, pseudocolumella. Stalk cylindrical, deeply striate, reddish-brown, translucent, narrower towards the sporangial end, broader towards the hypothallus which is not infrequently confluent. Capillitium consisting of abundant, filiform, forking threads, pale yellowish in colour, interconnecting fusiform yellow lime knots and yellowish spine-like processes which measures nearly $200\ \mu$ or longer and about $15\text{--}20\ \mu$ in diameter, extending from the outer wall of the sporangium to the surface of the trumpet-like pseudocolumella, densely packed with lime granules. Spores deep violet brown in mass, pale illac brown individually in transmitted light, spherical, almost smooth, measuring $6\text{--}7\text{--}(8)\ \mu$ in diameter (Text-Figs. 190-94).

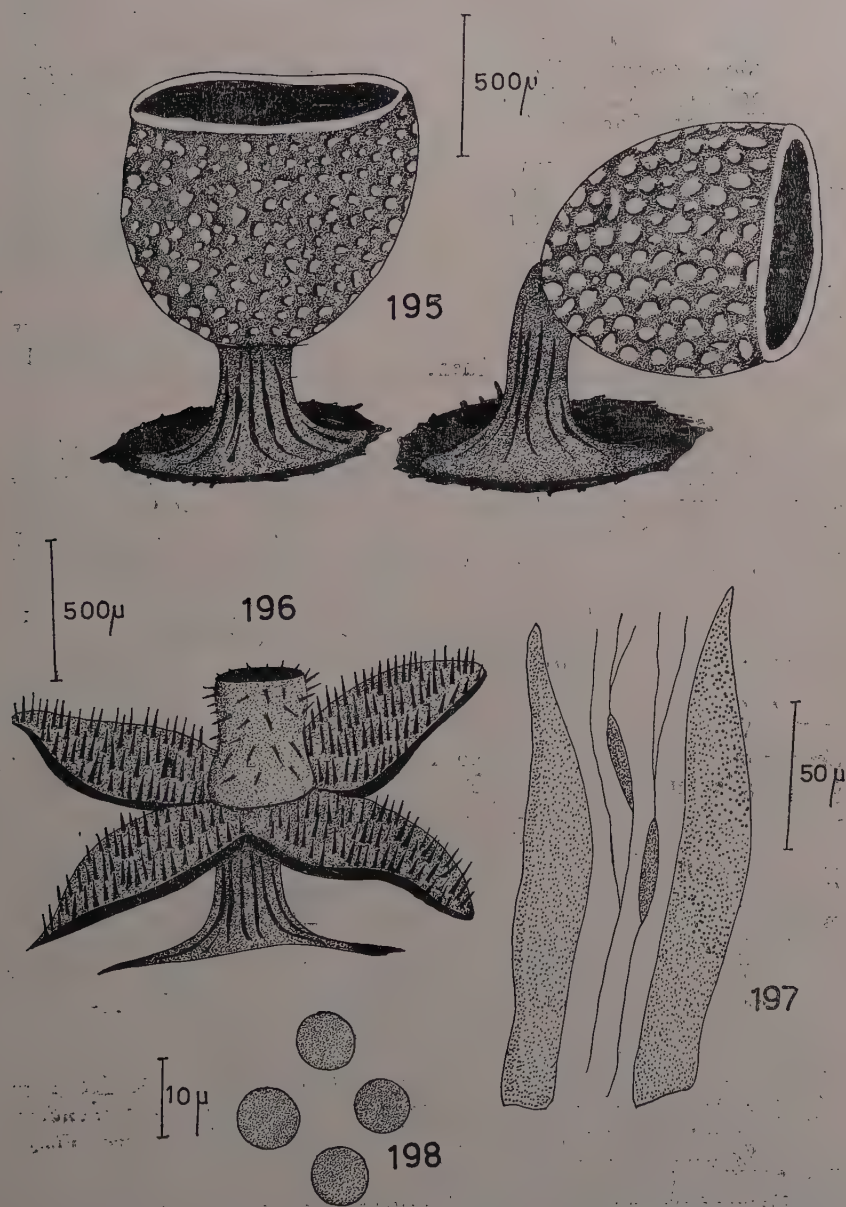
Atypical forms of this myxomycete are rather common in the same colony. In a few instances there is a tendency towards the formation of ill-defined plasmodiocarps. In one collection the sporangia are very short, about 1 mm. wide and as much high. The peridium is prominently speckled with flakes. The stalk is extremely reduced so that the sporangia appear almost sessile to the unaided eye. The stipe is broad-based, reddish-brown and expands into an ample hypothallus which is concolorous with the stalk. This form closely fits in, with the description of *Physarum rufibasis* Berkeley and Broome (1873). In this form fructifications with irregularly expanded sporangia are common (Text-Figs. 195-98).

Despite the wide variations in size and form presented by this species, the general morphology is fairly distinctive to facilitate easy identification. The well formed typical representatives of this species present striking aspect both in the dehiscent as well as predehiscent stages, in the former of which the peridial flaps unfold in a flower-like manner exposing the beautiful trumpet-shaped pseudocolumella and the curious spine-like calcareous processes of the capillitium. In old collections, however, only the petaloid peridial expansion without the characteristic spine-like processes were observed.

On soil, Nazira, Coll.: G. C. S. B., 12-6-1957 (M.H.T.E.S. No. 135); on soil, Jorhat, Coll.: V. A., 14-6-1957 (M.H.T.E.S. No. 136); on undetermined decaying bark, Jorhat, Coll.: H. K. P., 14-6-1957 (M.H.T.E.S. No. 137); on bark of a tea bush, Tocklai, Coll.: H. K. P., 12-8-1957 (M.H.T.E.S. No. 138); on decaying bark of *Albizia stipulata* Boiv., Cinnamara, T. E., Coll.: V. A., 18-5-1958 (M.H.T.E.S. No. 139); on soil, Tocklai, Coll.: W. Hadfield, 14-8-1958 (M.H.T.E.S. No. 140); on undetermined decaying bark, entomology plots, Tocklai, Coll.: H. K. P., 26-8-1958 (M.H.T.E.S. No. 141).



TEXT-FIGS. 190-94. *Physarella oblonga* (Berk. and Curt.) Morgan (M.H.T.E.S. No. 137). Fig. 190. Sporangia on decaying bark. Fig. 191. An erect and a nodding sporangium. Fig. 192. Sporangium showing the reflexed petaloid lobes with the calcareous spines and the trumpet-shaped pseudocolumella. Fig. 193. Calcareous nodes and the capillitial threads. Fig. 194. Spores.



TEXT-FIGS. 195-98. *Physarella oblonga* (Berk. and Curt.) Morgan (M.H.T.E.S. No. 138). Fig. 195. Sporangia with wide hypothallus and shortened stipes. Fig. 196. A dehiscing sporangium showing the petaloid peridium, calcareous spines of the capillitium and the doliform pseudocolumella. Fig. 197. Calcareous spines of the capillitium. Fig. 198. Spores.

48. *Diderma effusum* (Schweinitz) Morgan in *J. Cinc. Soc. Nat. Hist.*, 16, p. 16, 1894; Lister, A., *A Monograph of the Mycetozoa*, pp. 85-86, 1925, as *Diderma effusum* Morgan; Martin, G. W., *North American Flora, Fungi-Myxomycetes*, p. 134, 1949; Agnihothrudu, V., *J. Indian bot. Soc.*, 35, pp. 216-17, 1956; Thind, K. S. and Sohi, H. S., *Indian Phytopathology*, 9, pp. 3-4, 1956.

This is quite abundant locally. The sporangiate and plasmodiocarpous phases are equally of frequent occurrence. In the plasmodiocarpous phase the fructification is continuous in an even, thin mass, not broken into separate sporangia or plasmodiocarps and often presents reticulate growth showing lines of entirely confluent plasmodiocarps. In some instances, it is merely one continuous sheet of confluent plasmodiocarps (M.H.T.E.S. Nos. 146, 147 and 153). In these forms the capillitium is rather sparse. This type of plasmodiocarps were, however, not observed in any of the South Indian collections (Agnihothrudu, 1956 b).

In another form of the same species occurring here, the individual plasmodiocarps and sporangia are fairly well separated and discrete although remaining partly confluent at some places. Here the fructification is more or less flattened as in *Diderma chondrioderma* (De Bary and Rostafinski) G. Lister but is definitely thicker than the thin effuse form. The capillitium is fairly abundant and conforms in all respects to the description of the typical species. This species differs from *Diderma chondrioderma* in being more gregarious and in having smaller spores that are 7-8 (-10) μ in diameter.

On decaying leaves of *Artocarpus integrifolia* L., Cinnamara, T. E. Coll.: V. A., 12-2-1957 (M.H.T.E.S. No. 146); on living leaves of *Setaria* sp., Tocklai, Coll.: V. A., 14-2-1957 (M.H.T.E.S. No. 147); on living leaves of an unidentified graminæ, Hatichunghi, T. E., Coll.: V. A., 14-2-1957 (M.H.T.E.S. No. 148); on decaying leaf-sheath of *Areca catechu* L., Jorhat, Coll.: G. C. S. B., 12-4-1957 (M.H.T.E.S. No. 149); on living leaves of undetermined weeds, Tocklai, Coll.: V. A., 22-5-1957 (M.H.T.E.S. No. 150); on decaying leaves of a Scitamineæ, Nazira, Coll.: G. C. S. B., 12-6-1957 (M.H.T.E.S. No. 152); on decaying leaves of *Mangifera indica* L., Cinnamara, T. E., Coll.: V. A., 10-7-1957 (M.H.T.E.S. No. 153); on living leaves of an undetermined Cucurbitaceæ, Jorhat, Coll.: G. C. S. B., 10-8-1957 (M.H.T.E.S. No. 154).

49. *Diderma chondrioderma* (de Bary and Rostafinski) G. Lister in *A Monograph of the Mycetozoa*, p. 258, as *Diderma chondrioderma* G. Lister; Martin, G. W., *North American Flora, Fungi-Myxomycetes*, p. 134, 1949.

Plasmodium not observed. Sporangia scattered to subgregarious, typically disciform and sessile. No stalked members of the species were observed. Plasmodiocarps few, diameter of the sporangia up to 0.75 mm. milk-white. No purplish or pinkish-grey fructifications were encountered in local collections. Peridium thin, membraneous,

impregnated with deposits of round or angular lime knots united to form a thin, egg-shell-like crust which breaks off exposing an inner non-calcareous peridial layer. Columella present, low, convex, fairly large, flesh to maroon coloured, appearing as a prominent thickening of the sporangial floor with deposits of calcareous granules often found intermixed with dark coloured refuse matter; capillitium coarse, purplish to subhyaline threads which are simple or sparingly branched. Spores deep purplish-brown in mass, Violaceous brown in transmitted light, spherical spinulose, measuring 10-12 (-14) μ in diameter (Text-Figs. 199-204).

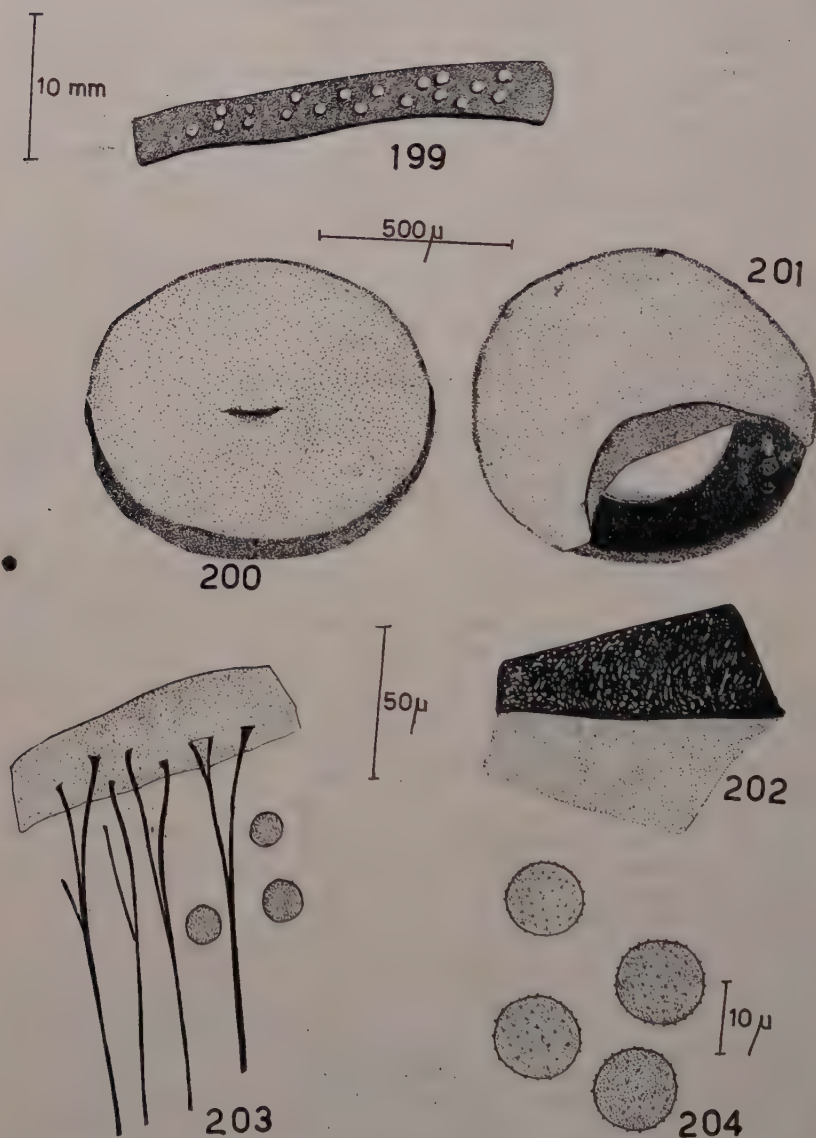
This species is fairly distinctive by the flat, discoid sporangia it produces and differs sharply from *Diderma effusum* (Schw.) Morgan in having larger spores and often coarser and somewhat persistent capillitium and in the scattered nature of the fructifications.

On decaying leaves of *Lagerstræmia* sp., Tocklai, Coll.: V. A., 23-5-1957 (M.H.T.E.S. No. 142); on decaying leaves of *Grevillea robusta* A. Cunn., Tocklai, Coll.: V. A., 23-5-1957 (M.H.T.E.S. No. 143); on undetermined weeds, Nazira, Coll.: G. C. S. B., 15-7-1958 (M.H.T.E.S. No. 144); on fronds of *Pteris* sp., Nazira, Coll.: G. C. S. B., 5-7-1958 (M.H.T.E.S. No. 145).

50. *Diderma hemisphericum* (Bulliard) Hornemann in *Abbildung von Pflanzen zu dem Werke Flora Danica*, 33, p. 13, 1829; Lister, A., *A Monograph of the Mycetozoa*, pp. 84-85, 1925, as *Diderma hemisphericum* Hornm., Martin, G. W., *North American Flora, Fungi-Myxomycetes*, p. 135, 1949; Agnihothrudu, V., *J. Indian bot. Soc.*, 33, pp. 185-88, 1954.

A fairly abundant species occurring on decaying vegetable debris. The species is very close to *Diderma effusum* with which it is easily confused but the latter is always sessile while *D. hemisphericum* occurring here is more often stipitate than not. The stipe in most of the collected specimens is more or less well developed although very short. There are, however, collections in which the stalk is reduced to a trace only. No plasmodiocarpous forms were observed.

On decaying leaves of *Ficus elastica* Roxb., Coll.: V. A., 22-11-1956 (M.H.T.E.S. No. 158); on decaying leaves of *Grevillea robusta* A. Cunn., Tocklai, Coll.: V. A., 3-2-1957 (M.H.T.E.S. No. 159); on an undetermined twig, Jorhat, Coll.: H. K. P., 4-3-1957 (M.H.T.E.S. No. 160); on a leaflet of *Albizia lebbek* Benth., Borbhetta experimental plots, Coll.: V. A., 12-3-1957 (M.H.T.E.S. No. 161); on decaying tea leaf, Cinnamara, T. E., Coll.: V. A., 17-4-1957 (M.H.T.E.S. No. 162); on living leaf blades of an undetermined grass, Jorhat, Coll.: G. C. S. B., 23-5-1957 (M.H.T.E.S. No. 163); on living leaves of seedlings of *Grevillea* sp., Agricultural College, Jorhat, Coll.: V. A., 20-5-1957 (M.H.T.E.S. No. 164); on lawn grasses, Tocklai, Coll.: V. A., 3-6-1957 (M.H.T.E.S. No. 165); on an undetermined leaf, Tyroon, T. E., Coll.: V. A., 6-6-1957 (M.H.T.E.S. No. 166);



TEXT-FIGS. 199-204. *Diderma chondrioderma* (de Bary and Rost.) G. Lister (M.H.T.E.S. No. 143). Fig. 199. Disciform sporangia on a leaf fragment. Fig. 200. A sporangium with the peridium intact. Fig. 201. A dehiscent sporangium showing the inner membranous peridium and columella on the floor of the sporangial cavity. Fig. 202. Peridial layers. Fig. 203. A fragment of the inner peridium and capillitial threads. Fig. 204. Spores.

on living leaves of *Centella asiatica* Urb., Hatichunghi, T. E., Coll.: V. A., G. C. S. B., and K. C. Sarmah, 18-6-1957 (M.H.T.E.S. No. 167); on living leaves of *Eleusine ægyptiaca* Desf., Jorhat, Coll.: V. A., 18-6-1957 (M.H.T.E.S. No. 168); on decaying leaves of *Ochroma balsa* Tocklai, Coll.: K. C. Sarmah, 27-9-1957 (M.H.T.E.S. No. 169); on undetermined decaying leaves, Entomology plots, Tocklai, Coll.: V. A., 14-11-1957 (M.H.T.E.S. No. 170); on stems of an undetermined dicotyledonous host, Jorhat, Coll.: H. K. P., 14-6-1958 (M.H.T.E.S. No. 171).

51. *Didymium nigripes* (Link) Fries in *Syst. Myc.*, 3, p. 119, 1829; Lister, A., *A Monograph of the Mycetozoa*, pp. 116-17, 1925, as *Didymium nigripes* Fr.; Martin, G. W., *North American Flora, Fungi-Myxomycetes*, p. 146, 1949; Agnihothrudu, V., *J. Indian bot. Soc.*, 35, pp. 31-32, 1956; Thind, K. S. and Sohi, H. S., *Indian Phytopathology*, 19, pp. 2-3, 1956.

Only one collection of this species was made. The sporangia have dark, almost black, translucent stalks and the columella is prominent, dark and globose. The columella is elevated in the centre of the sporangium. *Didymium nigripes* bears very close resemblance to *D. minus* (Lister) Morgan with which it may be confused but the latter is always described as having generally shorter stipes which are opaque.

On dead fruits of *Areca catechu* L., Borbhetta experimental plots, Coll.: G. C. S. B., and P. C. Chakravorty, 14-4-1957 (M.H.T.E.S. No. 155).

52. *Didymium clavus* (Albertini and Schweinitz) Rabenhorst in *Deuts. Krypt.-Fl.*, 1, p. 280, 1844; Lister, A., *A Monograph of the Mycetozoa*, p. 114, 1925, as *Didymium clavus* Rabenhorst; Martin, G. W., *North American Flora, Fungi-Myxomycetes*, p. 144, 1949; Agnihothrudu, V., *J. Indian bot. Soc.*, 35, pp. 28-29, 1956.

This species is rare locally. It appears to be fairly abundant in the South where nearly seven collections of the same species on different substrata were made in the neighbourhood of Madras (Agnihothrudu, 1956 a). Its distinctive features are the stipitate disciform sporangia that are devoid of any columella. In the place of the columella, there is the black thickened base of the peridial wall.

On decaying vegetable débris, Tocklai, Coll.: V. A., 10-7-1958 (M.H.T.E.S. No. 156); on decaying leaves of *Musa* sp., Jorhat, Coll.: G. C. S. B., 7-8-1957 (M.H.T.E.S. No. 157).

ACKNOWLEDGEMENTS

I am grateful to the Director, Tocklai Experimental Station, Indian Tea Association, for his encouragement and kind permission to publish

this paper and to Mr. K. C. Sarmah for critically reviewing the manuscript. It is indeed with great pleasure and deep sense of gratitude, I recall that a few years ago Professor Dr. T. S. Sadasivan, Director, University Botany Laboratory, Madras, had induced me to follow the study of this fascinating group of Myxomycetes which has been a source of much pleasure during my leisure hours. I am much thankful to Messrs. Hare Krishna Phukon and Giris Chandra Sarmah Barua, my two indefatigable collaborators whose keen enthusiasm in fieldwork has brought a good many species to my notice.

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A CONTRIBUTION TO THE FLORA OF ALAGAR HILLS, KARANDAMALAIS AND SURROUNDING REGIONS IN MADURAI DISTRICT, MADRAS STATE

BY K. SUBRAMANYAM AND A. N. HENRY

Botanical Survey of India, Southern Circle, Coimbatore

(Received for publication on December 31, 1958)

INTRODUCTION

THE Alagar Hills (Melur Taluk, Madurai District) are situated to the north-east of Madurai. It is at the foot of these Hills that the famous Alagar Temple is situated, 13 miles away from Madurai City. The Alagar Hills consist of a couple of ridges running north to south enclosing two fertile valleys. The greatest length is 16 km. and the highest point 879 M. Closely associated with these hills (Venkateswara Ayyar, 1938) are the "Natham Hills" consisting of several groups round Natham Town, the chief of which are the Karandamalais. The Karandamalais measure some 10 km. across and are crowned by a small plateau.

In Alagar and Natham Hills the following places were visited: Scrub jungle on the southern range of Alagar Hills, Nupuraganga, Peria-aruvi and Karandamalais. A number of tanks are found in the plains adjacent to these hills and these were also visited for collection of aquatic plants. The hills, forests and plains mentioned above lie between latitudes $10^{\circ} 0'$ and $10^{\circ} 30' N.$ and $77^{\circ} 55'$ and $78^{\circ} 20' E.$ longitudes.

Four exploration trips were made for the collection of plants in these areas, the itineraries of which are as follows:—

Exploration I	9-6-1957	.. Pond at Nagari, on Madurai-Dindigul Road.
	10-6-1957	.. Foot of Alagar Hills.
	11-6-1957	.. Alagar Temple to Nupuraganga.
	12-6-1957	.. Poyakarai.
	13-6-1957	.. Peria-aruvi.
	14-6-1957	.. Round about Alagar Temple.
	15-6-1957	.. Perumalmalai.

Exploration II	17-9-1957	.. Pond at Vadipatti, on Madurai-Dindigul Road.
	18-9-1957	.. Foot of Alagar Hills.
	19-9-1957	.. Alagar Temple to Nupuraganga.
	20-9-1957	.. Poyakarai and Kallandiri.
	21-9-1957	.. Periathopu and Allampatti, Melur Taluk.
	22-9-1957	.. Oomatchikolam and Peria-aruvi.
	23-9-1957	.. Kallandiri and Perumalmalai.
Exploration III	14-2-1958	.. Nallakolam and Kallandiri.
	15-2-1958	.. Karandamalais.
	16-2-1958	.. Peria-aruvi.
	17-2-1958	.. Foot of Alagar Hills.
	19-2-1958	.. Alagar Temple to Nupuraganga.
	20-2-1958	.. Pulakolam, on Natham-Dindigul Road.
Exploration IV	21-4-1958	.. Peria-aruvi and along the road to Natham.
	22-4-1958	.. Karandamalais.
	23-4-1958	.. Nupuraganga, foot of Alagar Hill and Kallandiri (Refer Map).

GEOLOGY, ROCK AND SOIL

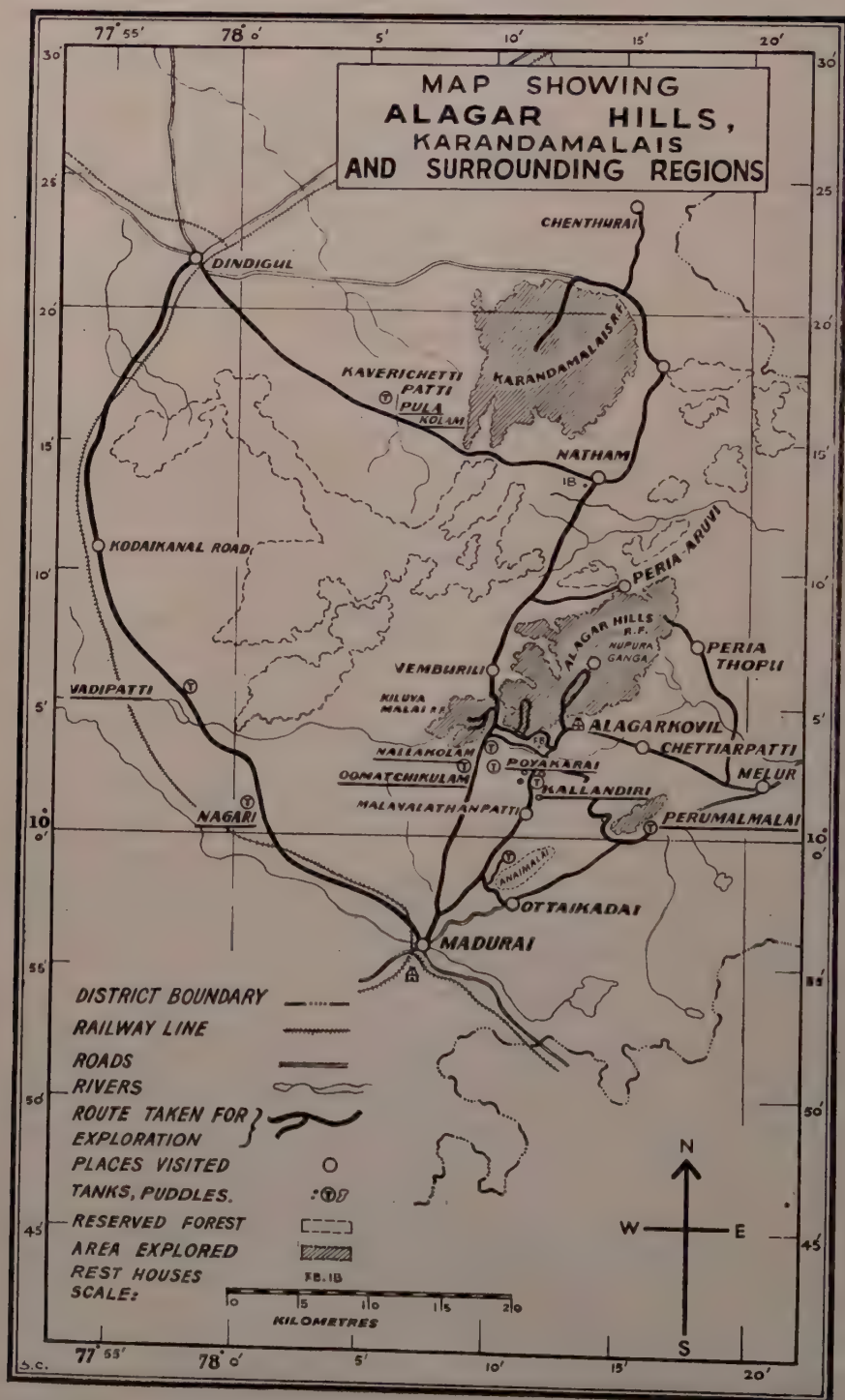
The hills in the Madurai District consist of gneissic rocks. Granular quartz is prominent in the Alagar Hills. In the plains where there is black cotton soil, there is the frequent occurrence of limestone. The soil in the low hills is shallow, stony and dry.

CLIMATE

The extremes of shade temperature in the plains are between 15° and 30° C. The hottest part of the year is April to June. The average annual rainfall is nearly 86 cm.; the rainfall is very irregular and the major portion of the rain is received by the north-east monsoon. The rains are usually heavy in the months of October and November.

VEGETATION

The vegetation at the foot of these hills is of the scrub jungle type and at slightly higher levels we have the open mixed deciduous forests;



at still higher elevations the evergreen and grassland formations are noticed. In the scrub jungle and the mixed deciduous forests the following species are common: *Acacia ferruginea*, *Acacia latronum*, *Acacia planifrons*, *Albizzia amara*, *Albizzia lebbeck*, *Albizzia odoratissima*, *Atalantia monophylla*, *Canthium dicoccum*, *Cassia marginata*, *Chloroxylon swietenia* and *Wrightia tinctoria*. Less important species that occur in these forests are: *Acacia caesia*, *Cassia montana*, *Dichrostachys cinerea*, *Dodonaea viscosa*, *Givotia rottleriformis*, *Gyrocarpus americanus*, *Moringa oleifera*, *Pterolobium indicum* and *Randia dumetorum*. Many of these are good fuel species.

The timber forests are found in the Peria-aruvi Valley of the Alagar Hills and the Kalanai Valley of the Karandamalais. The most remarkable feature common to these valleys is the existence of a number of large trees of *Artocarpus hirsuta*, *Bischofia javanica*, *Ficus glomerata*, *Mangifera indica* and *Terminalia arjuna* among other species. They are usually found on either side of the streams flowing through the valleys. Under the shades of these huge trees and along the streams a number of ferns like *Ceratopteris siliquosa*, *Nephrodium molle*, *Nephrodium unitum* and *Nephrolepis exaltata* grow very luxuriantly. The common orchids growing epiphytically on the trees are *Acampe praemorsa* and *Cymbidium alvifolium*.

A very noteworthy feature in the Peria-aruvi Valley is the occurrence of a large population of *Cycas circinalis*.

Bambusa bambos is the common species found here and it occurs mainly in the northern valley (Peria-aruvi) of the Alagar Hills. At Nupuraganga, a holy spring in the Alagar Hills, there are few trees of *Swietenia mahagoni* (Mahagony) planted long ago.

OBSERVATIONS

As already stated four seasonal explorations were made and in all a total number of 380 species were collected. These plants which are enumerated in succeeding pages have been carefully observed in the field and collected on the spot. They were satisfactorily compared with specimens in the Madras Herbarium at the Agricultural College and Research Institute, Coimbatore (now transferred to the Southern Circle, Botanical Survey of India). The classification of Bentham and Hooker is followed and the species under each family are arranged in an alphabetical order. For each species the following data are given: locality, occurrence, flowering or fruiting stage, date of collection, altitude and finally the herbarium sheet number of the Southern Circle of the Botanical Survey of India. Every attempt has been made to bring the nomenclature up to date and the following papers by Chatterjee and Bhardwaja (1957), Chopra, Badwar and Ghosh (1949), Chopra, Nayar and Chopra (1956), Mukerjee (1940), Pennell (1934), Raizada (1958), Razi (1954) and Santapau (1951, 1953 a, b, 1954, 1955 and 1957) have been very useful in this connection. The description

of the listed species is found in Gamble's Flora (1915 to 1936) of the Presidency of Madras.

Out of the plants listed the dominant families are Leguminosæ, Euphorbiaceæ and Gramineæ. The number of genera and species collected from these families are given in Table I.

TABLE I

Family	No. of Genera	No. of Species
Leguminosæ ..	22	36
Euphorbiaceæ ..	17	24
Gramineæ ..	15	17

It will be noticed from Table I that Leguminosæ is very well represented with the largest number of genera and species, the next in order being Euphorbiaceæ and Gramineæ. Among other families which have 8 or more species are Capparidaceæ, Malvaceæ, Rubiaceæ, Compositæ, Asclepiadaceæ, Scrophulariaceæ, Acanthaceæ, Verbenaceæ, Amaranthaceæ, Urticaceæ and Cyperaceæ. Further, it will be also seen from the list that the herbs and shrubs are better represented than the trees and climbers.

During the four seasonal trips in the forests around Alagar Hills and Karandamalais populations of some species of plants were dominantly in full bloom in certain large areas of the forest. The phenological observations on these species are given in Table II.

As mentioned there is quite a large number of tanks and puddles round about Alagar Hills and Karandamalais. The aquatic plants in these tanks, lakes and puddles were also visited regularly during the exploration trips and a total number of 49 Hydrophytes were collected. A detailed distribution of these aquatic plants in the various habitats of these areas is shown in Table III.

Further on the basis of our collections the following taxonomic data could be given for the vascular hydrophytes:—

	Families	Genera	Species
<i>Lycopsidea</i>			
Isætales	1	1	1
<i>Pteropsida</i>			
Filicales	2	2	2
Angiospermae:			
Dicotyledoneæ ..	12	18	22
Monocotyledoneæ ..	11	16	24
TOTAL ..	26	37	49

TABLE II

Name	Explo- ration Trip No.	Date of flowering (Range)	Locality
<i>Abrus precatorius</i> Linn. ..	II	18-9-1957 to 23-9-1957	Foot of Alagar Hills
<i>Acacia latronum</i> Willd. ..	III	14-2-1958 to 20-2-1958	" " "
<i>Barleria noctiflora</i> Linn. f.	I	10-6-1957 to 15-6-1957	" " "
<i>Capparis sepiaria</i> Linn. ..	I	10-6-1957 to 15-6-1957	" " "
<i>Commiphora caudata</i> (W. & A.) Engl.	IV	21-4-1958 to 23-4-1958	Way to Nupuraganga
<i>Dichrostachys cinerea</i> W. & A.	I	10-6-1957 to 15-6-1957	Foot of Alagar Hills
<i>Dioscorea hispida</i> Dennst.	II	18-9-1957 to 23-9-1957	Peria-aruvi
<i>Glycosmis pentaphylla</i> (Retz.) Correa.	IV	21-4-1958 to 23-4-1958	Way to Karandamalais
<i>Gyrocarpus americanus</i> Jacq.	III	14-2-1958 to 20-2-1958	Karandamalais
<i>Hugonia mystax</i> Linn. ..	I	10-6-1957 to 15-6-1957	Foot of Alagar Hills
<i>Mimosa rubicaulis</i> Lamk.	II	18-9-1957 to 23-9-1957	" " "
<i>Murraya paniculata</i> (Linn.) Jack.	IV	21-4-1958 to 23-4-1958	Karandamalais
<i>Pisonia aculeata</i> Linn. ..	III	14-2-1958 to 20-2-1958	Karandamalais, Peria-aruvi and Nupuraganga
<i>Rhus mysorensis</i> Heyne ..	III	14-2-1958 to 20-2-1958	Foot of Alagar Hills
<i>Symphorema involucratum</i> Roxb.	IV	21-4-1958 to 23-4-1958	Peria-aruvi and Karandamalais

TABLE III

No.	Name of Plant	Habitats*							
		1	2	3	4	5	6	7	8
1	<i>Aeschynomene aspera</i> Linn.	+	—	—	—	+	+	—	—
2	<i>Aeschynomene indica</i> Linn. ..	+	—	—	—	—	—	—	—
3	<i>Ammannia baccifera</i> Linn. var. <i>ægyptiaca</i> Koehne.	+	—	+	—	+	+	—	+
4	<i>Ammannia multiflora</i> Roxb.	—	—	+	—	+	—	—	—
5	<i>Ammannia octandra</i> Linn. f.	—	—	—	—	—	—	+	—
6	<i>Aponogeton natans</i> Engl. & Kr.	—	—	—	+	—	—	—	+
7	<i>Asteracantha longifolia</i> (Linn.) Nees.	+	—	—	—	+	+	—	+
8	<i>Bacopa monnieri</i> (Linn.) Pennell	+	—	+	+	—	+	+	+
9	<i>Bergia capensis</i> Linn. ..	—	—	—	—	—	—	—	+
10	<i>Ceratopteris siliquosa</i> (Linn.) Copel.	+	—	—	—	—	—	—	—
11	<i>Cyanotis axillaris</i> R. & S. ..	+	—	+	—	—	+	+	—
12	<i>Cyperus articulatus</i> Linn. ..	—	—	—	—	+	+	—	—
13	<i>Cyperus difformis</i> Linn. ..	+	—	—	—	—	+	—	—
14	<i>Cyperus eleusinoides</i> Kunth.	—	—	—	—	+	+	—	+
15	<i>Cyperus exaltatus</i> Retz. ..	—	—	—	—	—	+	—	+
16	<i>Cyperus tenuispica</i> Steud. ..	—	—	—	+	—	—	—	—
17	<i>Dentella repens</i> Forst. ..	—	—	—	—	—	+	—	—
18	<i>Dopatrium lobelioides</i> Benth.	+	—	—	+	—	—	—	—
19	<i>Eichhornia crassipes</i> Solms.	+	+	—	—	—	—	—	—
20	<i>Eriocaulon quinquangulare</i> Linn.	—	—	+	—	+	—	—	—
21	<i>Eriochloa procera</i> C.E. Hubb.	+	—	—	—	—	—	—	+
22	<i>Fimbristylis miliacea</i> Vahl. ..	+	—	—	+	—	—	—	+
23	<i>Glossostigma spathulatum</i> Arn.	—	—	+	—	—	—	—	—
24	<i>Hydrolea zeylanica</i> Vahl. ..	+	—	—	—	—	—	—	—
25	<i>Isoetes coromandelina</i> Linn.	—	—	+	—	+	—	—	—
26	<i>Jussiaea repens</i> Linn. ..	+	—	—	—	+	+	—	—
27	<i>Lagarosiphon alternifolius</i> (Roxb.) Druce.	+	—	—	—	—	—	—	—
28	<i>Lemna paucicostata</i> Hegelm.	+	—	—	—	—	—	—	—
29	<i>Linnophila indica</i> (Linn.) Druce.	+	—	—	—	—	—	—	—

TABLE III—Contd.

No.	Name of Plant	Habitats*							
		1	2	3	4	5	6	7	8
30	<i>Limnophyton obtusifolium</i> Miq.	—	—	—	—	—	—	+	—
31	<i>Marsilea minuta</i> Linn.	..	+	—	—	—	—	—	+
32	<i>Monochoria hastaeifolia</i> Presl.	+	—	—	—	+	—	—	—
33	<i>Monochoria vaginalis</i> Presl.	..	+	+	—	—	—	—	—
34	<i>Nelumbo nucifera</i> Gaertn.	..	+	—	—	+	+	—	—
35	<i>Neptunia oleracea</i> Lour.	..	+	+	—	—	—	—	+
36	<i>Nymphæa stellata</i> Willd.	..	—	—	—	—	+	—	+
37	<i>Nymphæa pubescens</i> Willd.	..	—	+	—	—	+	—	—
38	<i>Ottelia alismoides</i> Pers.	..	+	—	+	—	+	—	+
39	<i>Phyla nodiflora</i> (Lina.) Greene	+	—	+	+	—	+	—	+
40	<i>Polygonum glabrum</i> Willd.	..	+	—	—	+	+	—	+
41	<i>Potamogeton indicus</i> Roxb.	..	+	—	+	—	+	—	+
42	<i>Rotala verticillaris</i> Linn.	..	—	—	—	+	—	—	—
43	<i>Scirpus articulatus</i> Linn.	..	+	—	+	—	+	—	—
44	<i>Scirpus jacobii</i> Fischer	..	—	—	—	—	—	+	—
45	<i>Scirpus squarrosus</i> Linn.	..	—	—	—	+	+	—	—
46	<i>Scirpus supinus</i> Lina.	..	—	—	+	—	+	—	—
47	<i>Sphenoclea zeylanica</i> Gaertn.	+	—	—	+	—	—	—	—
48	<i>Typha angustata</i> Bory & Chaub.	+	—	—	—	+	—	—	+
49	<i>Wolffia arrhiza</i> Wimm.	..	+	—	—	—	—	—	—

* 1. Tanks and small puddles at Kallandiri.

5. Perumal Koil Tank.

2. Pond at Nagari.

6. Poyakarai Tank.

3. Nallakolam.

7. Pulakolam.

4. Oomatchikclam.

8. Pond at Vadipatti.

+ Present

— Absent

ENUMERATION

ISCETACEÆ

Isoetes coromandelina Linn. Perumal Koil Tank at the foot of Perumalmalais near Alagar Hills, common, sporophyll fertile (15-6-1957), 83 M, 3506; Nallakolam, Cheegapatti near Alagar Hills, common, sporophyll fertile (14-2-1958), 200 M.

MARSILEACEÆ

Marsilea minuta Linn. On the road to Alagar Hills from Natham, common, with sporocarp (14-2-1958), 200 M, 5281.

POLYPODIACEÆ

Adiantum caudatum Linn. In moist shady places, Peria-aruvi, Alagar Hills, common, with sorus (13-6-1957), 300 M, 3470.

Ceratopteris siliquosa (Linn.) Copel. Along a stream at Periathopu, near Allampatti, Melur Taluk, common, with sorus (21-9-1957), 167 M, 4323.

Nephrodium molle Desv. By the side of a stream in cool shady places, Peria-aruvi, Alagar Hills, very common, with sorus (13-6-1957), 400 M, 3474.

Nephrodium unitum Linn. By the side of a stream in cool shady places, Peria-aruvi, Alagar Hills, common, with sorus (13-6-1957), 400 M, 3480.

Nephrolepis exaltata Linn. By the side of a stream in cool shady places, Peria-aruvi, Alagar Hills, very common, with sorus (13-6-1957), 400 M, 3479.

RANUNCULACEÆ

Clematis gouriana Roxb. Peria-aruvi, Alagar Hills, common, in fruit (16-2-1958), 266 M, 5333.

ANONACEÆ

**Alphonsea sclerocarpa* Thw. Karandamalais, few, in flower and fruit (22-4-1958), 400 M, 5741.

Miliusa eriocarpa Dunn. Along the road to Nupuraganga from Alagar Temple, common, in flower (11-6-1957), 267 M, 3404.

**Polyalthia korinti* Hk. f & T. Karandamalais, few, in flower (22-4-1958), 500 M, 5748.

MENISPERMACEÆ

Cissampelos pareira Linn. Peria-aruvi, Alagar Hills, common, in flower (22-9-1957), 333 M, 4337.

Cocculus hirsutus Diels. Foot of Alagar Hills, common, in flower and fruit (18-9-1957), 167 M, 4251.

Diploclisia glaucescens (Bl.) Diels. Peria-aruvi, Alagar Hills, common, in flower (21-4-1958), 333 M, 5731.

Pachygone ovata Miers. Karandamalais near Natham, common, in flower (15-2-1957), 333 M, 5315.

Tiliacora acuminata (Lamk.) Miers. Peria-aruvi, Alagar Hills, few, in flower (13-6-1957), 333 M, 3483, 5757.

NYPHÆACEÆ

Nelumbo nucifera Gaertn. Poyakarai Pond near Alagar Hills, very abundant, in flower—rose coloured and fruit (12-6-1957), 167 M, 3425; Perumal Koil Tank at the foot of Perumalmalai near Alagar Hills, abundant, in flower—white coloured (15-6-1957), 83 M, 3507.

Nymphaea pubescens Willd. In a pond at Nagari village, on the road to Madurai from Dindigul, common, in flower—white coloured (9-6-1957), 167 M, 3089; In a small pond near Poyakarai, Alagar Hills, few, in flower—red coloured (20-9-1957), 167 M, 4291.

**Nymphaea stellata* Willd. Poyakarai Pond near Alagar Hills, common, in flower—blue coloured (12-6-1957), 167 M, 3422; In a pond near Vadipatti on the road to Madurai from Dindigul, common, in flower—rose and white coloured (17-9-1957), 167 M, 4234, 4235.

CAPPARIDACEÆ

Cadaba farinosa Forsk. Perumalmalai near Alagar Hills, common, in flower (23-9-1957), 83 M, 4353.

**Cadaba trifoliata* W. & A. Foot of Alagar Hills, common, in flower (17-2-1958), 133 M, 5344.

Capparis sepiaria Linn. Foot of Alagar Hills, common, in flower (10-6-1957), 167 M, 3358.

Cleome aspera Koen. In cultivated fields on the way to Poyakarai, Alagar Hills, common, in flower and fruit (20-9-1957), 133 M, 4281.

Cleome icosandra Linn. In paddy fields around Poyakarai Pond near Alagar Hills, common, in flower and fruit (12-6-1957), 133 M, 3439.

Gynandropsis gynandra (Linn.) Briq. Near Alagar Temple, common, in flower and fruit (23-9-1957), 167 M, 4358.

Maerua arenaria Hk. f & T. Foot of Alagar Hills, common, in flower (17-2-1958), 133 M, 5343.

Niebuhria apetala (Roth.) Dunn. Foot of Alagar Hills, rare, in flower and fruit (10-6-1957), 167 M, 3370.

VIOLACEÆ

Hybanthus enneaspermus (Linn.) F. V. Muell. In fields around Poyakarai Pond near Alagar Hills, common, in flower (12-6-1957), 167 M, 3433.

BIXACEÆ

Flacourtia indica (Burm.f.) Merr. On the road to Nupuraganga from Alagar Temple, common, in flower (19-9-1957), 200 M, 4260.

**Hydnocarpus laurifolia* (Dennst.) Sleumer. Karandamalais, common, in flower and fruit (22-4-1958), 500 M, 5731.

POLYGALACEÆ

Polygala chinensis Linn. Near Allampatti on Alagar Temple-Melur Road, common, in flower and fruit (21-9-1957), 75 M, 4309.

PORTULACACEÆ

Talinum cuneifolium Willd. On the way to Nupuraganga from Alagar Temple, cultivated, in flower and fruit (19-2-1958), 233 M, 5374.

ELATINACEÆ

Bergia ammannioides Roxb. Pulakolam, near Kaverichettipatti on Natham-Dindigul Road, common, in flower (20-2-1958), 233 M, 5388.

Bergia capensis Linn. In a pond near Vadipatti on the road to Madurai from Dindigul, common, in flower (17-9-1957), 167 M, 4240.

MALVACEÆ

Hibiscus lunariifolius Willd. Peria-aruvi, Alagar Hills, common, in flower and fruit (16-2-1958), 266 M, 5336.

Hibiscus micranthus Linn. f. Foot of Alagar Hills, common, in flower and fruit (10-6-1957), 167 M, 3091.

Hibiscus surattensis Linn. Peria-aruvi, Alagar Hills, common, in flower and fruit (16-2-1958), 266 M, 5337.

Pavonia zeylanica Boiss. Foot of Alagar Hills, common, in flower and fruit (17-2-1958), 133 M, 5347.

Sida acuta Burm. f. On the way to Nupuraganga from Alagar Temple, common, in flower (19-9-1957), 200 M, 4258.

Sida glutinosa Cav. On the road to Nupuraganga from Alagar Temple, common, in flower and fruit (19-2-1958), 266 M, 5383.

Sida veronicaefolia Lamk. Around Poyakarai Pond near Alagar Hills, common, in flower and fruit (12-6-1957), 133 M, 3429.

Urena lobata Linn. Peria-aruvi, Alagar Hills, common, in flower and fruit (16-2-1958), 266 M, 5328.

STERCULIACEÆ

Guazuma tomentosa Kunth. On the way to Nupuraganga from Alagar Temple, few, in flower (11-6-1957), 267 M, 3402.

Helicteres isora Linn. On the way to Peria-aruvi, Alagar Hills, common, in flower (22-9-1957), 266 M, 4334.

Melochia corchorifolia Linn. In cultivated fields on the way to Poyakarai, Alagar Hills, common, in flower (20-9-1957), 133 M, 4272.

**Sterculia foetida* Linn. Karandamalais, common, in flower (22-4-1957), 400 M, 5740.

Waltheria indica Linn. In cultivated fields on the way to Poyakarai, Alagar Hills, common, in flower (20-9-1957), 133 M, 4271.

TILIACEÆ

Grewia hirsuta Vahl. Periathopu near Allampatti, Melur Taluk, common, in bud and flower (21-9-1957), 167 M, 4321.

Grewia obtusa Wall. Along the road to Nupuraganga from Alagar Temple, common, in flower (11-6-1957), 267 M, 3387.

Grewia rhamnifolia Heyne. Near Nupuraganga, Alagar Hills, common, in flower (19-9-1957), 433 M, 4269.

LINACEÆ

Erythroxylum monogynum Roxb. Foot of Alagar Hills, common, in flower (10-6-1957), 133 M, 3359.

Hugonia mystax Linn. Foot of Alagar Hills, common, in flower (10-6-1957), 133 M, 3349.

ZYGOPHYLLACEÆ

**Tribulus terrestris* Linn. In paddy fields on the Natham-Madurai Road, common, in flower and fruit (21-4-1958), 200 M, 5722.

RUTACEÆ

Atalantia racemosa W. & A. Karandamalais near Natham, common, in flower (15-2-1958), 333 M, 5318.

**Chloroxylon swietenia* DC. Karandamalais, common, in flower (22-4-1958), 400 M, 5739.

Clausena deniata (Willd.) R. & S. Foot of Alagar Hills, common, in flower (10-6-1957), 133 M, 3371.

**Glycosmis pentaphylla* (Retz.) Correa. Chenthurai near the foot of Karandamalais, common, in flower (22-4-1958), 266 M, 5736.

Muraya paniculata (Linn.) Jack. Karandamalais, common, in flower (22-4-1958), 500 M, 5743.

SIMARUBACEÆ

Ailanthus excelsa Roxb. Karandamalais near Natham, common, in flower and young fruit (15-2-1958), 366 M, 5321.

OCHNACEÆ

Ochna squarrosa Linn. On the road to Nupuraganga from Alagar Temple, common, in flower (11-6-1957), 333 M, 3418.

Ochna wightiana Wall. Foot of Alagar Hills, common, in flower (10-6-1957), 133 M, 3363.

BURSERACEÆ

Commiphora berryi (Arn.) Engl. Foot of Alagar Hills, very common, in flower (10-6-1957), 133 M, 3374.

**Commiphora caudata* (W. & A.) Engl. On the way to Nupuraganga, Alagar Hills, common, in flower and fruit (23-4-1958), 333 M, 5760.

**Commiphora pubescens* Engl. Foot of Karandamalais, common, in flower (22-4-1958), 400 M, 5738.

MELIACEÆ

Azadirachta indica Juss. On the way to Nupuraganga, Alagar Hills, common, in flower (23-4-1958), 333 M, 5759.

Cipadessa baccifera Miq. Peria-aruvi, Alagar Hills, common, in flower (13-6-1957), 333 M, 3477.

Dysoxylum malabaricum Bedd. Peria-aruvi, Alagar Hills, few, in flower (13-6-1957), 333 M, 3484.

Swietenia mahagoni Linn. Munnur Forest Rest House, Alagar Hills, planted, in flower (14-6-1957), 133 M, 3500.

ICACINACEÆ (= OLACINEÆ B.H.)

Pyrenacantha volubilis Hook. On the way to Peria-aruvi, Alagar Hills, common, in flower (22-9-1957), 266 M, 4335.

CELASTRACEÆ

Elaeodendron glaucum Pers. Foot of Alagar Hills, common, in flower (10-6-1957), 167 M, 3364.

**Gymnosporia emarginata* Roth. Foot of Alagar Hills, common, in flower and fruit (17-2-1958), 133 M, 5346.

HIPPOCRATEACEÆ (= CELASTRACEÆ B.H.)

Loeseneriella obtusifolia (Roxb.) A. C. Smith. On the road to Nupuraganga from Alagar Temple, common, in flower (19-2-1958) 333 M, 5378.

Pristimera indica (Willd.) A. C. Smith. Foot of Alagar Hills, common, in flower and fruit (10-6-1957), 133 M, 3375, 4248.

RHAMNACEÆ

Scutia myrtina (Burm.) Kurz. Foot of Alagar Hills, common, in flower and fruit (17-2-1958), 133 M, 5341.

Ventilago maderaspatana Gaertn. Karandamalais near Natham, common, in flower (15-2-1958), 333 M, 5316.

**Zizyphus glabrata* Heyne ex Roth. On the road to Peria-aruvi, Alagar Hills, a few, in flower (21-4-1958), 233 M, 5726.

Zizyphus mauritiana Lamk. On the way to Nupuraganga from Alagar Temple, common, in flower (19-9-1957), 200 M, 4261.

Zizyphus xylopyrus Willd. Foot of Alagar Hills, common, in flower (10-6-1957), 133 M, 3351, 3472.

VITACEÆ (= AMPELIDEÆ B.H.)

Cissus quadrangularis Linn. Foot of Alagar Hills, very common, in flower (10-6-1957), 133 M, 3099.

Leea indica (Burm.) Merr. Peria-aruvi, Alagar Hills, common, in flower (13-6-1957), 333 M, 3481.

SAPINDACEÆ

Allophylus serratus Radlk. By the side of a stream at Periathopu near Allampatti, Melur Taluk, common, in flower (21-9-1957), 167 M, 4324.

Cardiospermum canescens Wall. On the road to Nupuraganga from Alagar Temple, very common, in flower (11-6-1957), 267 M, 3393; 4253 (in fruit).

Cardiospermum halicacabum Linn. Along the road to Karandamalais from Natham, common, in flower (15-2-1958), 200 M, 5304.

**Lepisanthes tetraphylla* (Vahl.) Radlk. On the way to Nupuraganga from Alagar Temple, rare, in flower (19-2-1958), in fruit (23-4-1958), 333 M, 5379, 5754.

Sapindus emarginatus Vahl. Karandamalais near Natham, few, in flower and fruit (15-2-1958), 333 M, 5320.

ANACARDIACEÆ

Mangifera indica Linn. On the way to Nupuraganga, Alagar Hills, common, in flower (23-4-1958), 333 M, 5758.

Nothopegia beddomei Gamble. Karandamalais, few, in flower (22-4-1958), 500 M, 5745.

**Rhus mysorensis* Heyne. Foot of Alagar Hills, common, in flower and fruit (17-2-1958), 133 M, 5345.

LEGUMINOSÆ

(LOTOIDEÆ)

Abrus precatorius Linn. Foot of Alagar Hills, common, in flower (18-9-1957), 167 M, 4244.

Aeschynomene aspera Linn. In a tank at Kallandiri near Alagar Hills, common, in flower and fruit (23-9-1957), 83 M, 4348.

Aeschynomene indica Linn. At Kuttupatti Tank, on the road to Karandamalais from Natham, common, in flower and fruit (15-2-1958), 200 M, 5312.

Canavalia ensiformis DC. Allampatti on the Alagar Temple-Melur Road, common, in flower (21-9-1957), 75 M, 4312.

Clitoria ternatea Linn. On the way to Nupuraganga from Alagar Temple, common, in flower and fruit (19-2-1958), 233 M, 5373.

Crotalaria verrucosa Linn. Near Alagar Temple, common, in flower and fruit (14-6-1957), 133 M, 3490; Karandamalais (22-4-1958), 500 M, 5744.

**Dalbergia coromandeliana* Prain. Foot of Alagar Hills, very common, in flower (10-6-1957), 167 M, 3362.

Dalbergia paniculata Roxb. Along the road to Nupuraganga from Alagar Temple, few, in flower and fruit (11-6-1957), 267 M, 3394.

Derris scandens Benth. Periathopu near Allampatti, Melur Taluk, common, in bud and flower (21-9-1957), 200 M, 4319.

Desmodium biarticulatum Benth. Near Allampatti on the Alagar Temple-Melur Road, common, in fruit (21-9-1957), 75 M, 4307.

Dolichos falcatus Klein. On the way to Karandamalais from Natham, common, in flower and fruit (15-2-1958), 200 M, 5302.

Erythrina mysorensis Gamblé. Alagar Temple Garden, cultivated, in flower (19-2-1958), 167 M, 5381.

Indigofera aspalathoides Vahl. In cultivated fields on the way to Poyakarai, Alagar Hills, common, in flower (20-9-1957), 133 M, 4275.

Indigofera enneaphylla Linn. On the bank of Poyakarai Pond, Alagar Hills, common, in flower (12-6-1957), 133 M, 3446.

Indigofera subulata Vahl. Foot of Alagar Hills, common, in flower (18-9-1957), 167 M, 4252.

Phaseolus trilobus Ait. Near Allampatti on the Alagar Temple-Melur Road, common, in flower and fruit (21-9-1957), 75 M, 4308.

Tephrosia hirta Ham. In cultivated fields on the way to Poyakarai, Alagar Hills, common, in flower and fruit (20-9-1957), 133 M, 4276.

Tephrosia purpurea Pers. Foot of Anamalai near Alagar Hills, common, in flower and fruit (15-6-1957), 83 M, 3504, 4299.

LEGUMINOSÆ (CÆSALPINIOIDEÆ)

Bauhinia tomentosa Linn. Foot of Alagar Hills, common, in flower (18-9-1957), 167 M, 4245.

Caesalpinia crista Linn. Peria-aruvi, Allagar Hills, common, in flower (22-9-1957), 333 M, 4339.

Cassia auriculata Linn. In dry open fields around Cheegapatti near Alagar Hills, common, in flower (14-2-1957), 200 M, 5293.

Cassia marginata Roxb. Foot of Alagar Hills near Munnur Forest Rest House, cultivated, in flower (10-6-1957), 133 M, 3376, 4279.

Cassia mimosoides Linn. Foot of Alagar Hills, common, in flower and fruit (18-9-1957), 133 M, 4247.

**Cassia montana* Heyne. Foot of Alagar Hills, common, in flower (18-9-1957), 167 M, 4255.

**Cassia obtusa* Roxb. Around Alagar Temple, common, in flower (14-6-1957), 167 M, 3497; 5724 (in fruit).

Cassia occidentalis Linn. On the way to Nupuraganga from Alagar Temple, common, in flower and fruit (11-6-1957) 267 M, 3383.

Pterolobium indicum A. Rich. Foot of Alagar Hills, abundant, in flower and fruit (10-6-1957), 167 M, 3357.

LEGUMINOSÆ

(MIMOSOIDEÆ)

Acacia arabica Willd. Foot of Alagar Hills, common, in flower (10-6-1957), 133 M, 3090.

Acacia chundra (Roxb.) Willd. Foot of Alagar Hills, common, in flower (18-9-1957), 167 M, 4256.

Acacia latronum Willd. Foot of Alagar Hills, common, in flower and fruit (17-2-1958), 133 M, 5342.

Acacia planifrons W. & A. Karandamalais near Natham, few, in flower (15-2-1958), 333 M, 5280.

Albizzia amara Boiv. Foot of Alagar Hills, common, in flower (10-6-1957), 167 M, 3356.

Albizzia lebbbeck Benth. On the road to Nupuraganga from Alagar Temple, common, in flower (19-2-1958), 233 M, 5377.

Dichrostachys cinerea W. & A. Foot of Alagar Hills, abundant, in flower (10-6-1957), 167 M, 3354.

**Mimosa rubicaulis* Lamk. Foot of Alagar Hills, common, in flower (18-9-1957), 267 M, 4243.

**Neptunia oleracea* Lour. In a small pond at Nagari village on the road to Madurai from Dindigul, abundant, in flower and fruit (9-6-1957), 167 M, 3088.

SAXIFRAGACEÆ

Vahlia digyna (Retz.) O. Ktze. In paddy fields near Vemburuli on the Natham-Madurai Road, common, in flower and fruit (12-6-1957), 233 M, 3460, 5298.

**Vahlia oldenlandioides* Roxb. At Kallandiri, Alagar Hills, common, in flower and fruit (14-2-1958), 133 M, 5297.

COMBRETACEÆ

**Combretum ovalifolium* Roxb. Foot of Alagar Hills, common, in flower (17-2-1958), 133 M, 5340.

Terminalia arjuna W. & A. On the way to Nupuraganga, Alagar Hills, common, in flower and fruit (23-4-1958), 267 M, 5753.

MYRTACEÆ

Syzygium cumini (Linn.) Skeels. Foot of Alagar Hills, few, in bud and flower (10-6-1957), 167 M, 3368.

MELASTOMACEÆ

Memecylon umbellatum Burm.f. On the road to Nupuraganga from Alagar Temple, few, in flower (11-6-1957), 267 M, 3415.

LYTHRACEÆ

Ammannia baccifera Linn. var. *aegyptiaca* Koehne. In paddy fields around Poyakarai Pond near Alagar Hills, common, in flower and fruit (12-6-1957), 133 M, 3440.

Ammannia multiflora Roxb. Near Appanthirupathi on the road to Alagar Temple from Madurai, common, in flower (20-9-1957), 83 M, 4300.

* *Ammannia octandra* Linn.f. In paddy fields on the Natham-Madurai Road, common, in flower and fruit (21-4-1958), 200 M, 5735.

Nesoea brevipes Koehne. On the road to Nupuraganga from Alagar Temple in moist shady places, common, in flower and young fruit (11-6-1957), 267 M, 3410.

Rotala verticillaris Linn. Along the margin of Perumal Koil Tank at foot of Perumalmalai near Alagar Hills, abundant, in flower and fruit (15-6-1957), 83 M, 3508.

ONAGRACEÆ

Jussiaea repens Linn. In a temple tank at the foot of Anamalai near Alagar Hills, common, in flower and fruit (15-6-1957), 83 M, 3503.

Ludwigia parviflora Roxb. Along the road to Nupuraganga from Alagar Temple in moist shady places, common, in flower and fruit (11-6-1957), 267 M, 3398.

SAMYDACEÆ

Casearia varians Bedd. Near Nupuraganga, Alagar Hills, rare, in fruit (19-9-1957), 367 M, 4264.

PASSIFLORACEÆ

Passiflora foetida Linn. Near Vemburuli on the road to Natham from Madurai, common, in flower and young fruit (12-6-1957), 233 M, 3447.

CUCURBITACEÆ

Coccinia cordifolia (Linn.) Cogn. Roadside near Vemburuli on the Natham-Madurai road, common, in flower (12-6-1957), 233 M, 3464.

Cucumis melo Linn. var. *agrestis* Naud. Near Allampatti on the Alagar Temple-Melur Road, common, in flower (21-9-1957), 75 M, 4305.

Melothria heterophylla Cogn. Foot of Alagar Hills, common, in flower (10-6-1957), 167 M, 3098, 4318.

AIZOACEÆ (= FICOIDEÆ B.H.)

Glinus oppositifolius (Linn.) A. DC. On the way to Nupuraganga from Alagar Temple, common, in flower and fruit (11-6-1957), 167 M, 3381.

Mollugo cerviana Ser. Foot of Alagar Hills, common, in flower and fruit (10-6-1957), 167 M, 3092.

- * *Mollugo nudicaulis* Lam. On the way to Nupuraganga from Alagar Temple, common, in flower and fruit (11-6-1957), 167 M, 3380, 4246.

UMBELLIFERÆ

Centella asiatica (Linn.) Urban. Along the road to Nupuraganga from Alagar Temple in moist shady places, very common, in flower and fruit (11-6-1957), 167 M, 3396.

RUBIACEÆ

Borreria hispida (Linn.) Schum. In cultivated fields on the way to Poyakarai, Alagar Hills, common, in flower and fruit (20-9-1957), 133 M, 4280.

Canthium dicoccum (Gaertn.) Merr. On the way to Nupuraganga from Alagar Temple, common, in flower and fruit (19-2-1958), 233 M, 5376.

- * *Dentella repens* Forst. In paddy fields around Poyakarai Pond near Alagar Hills, common, in flower and fruit (12-6-1957), 133 M, 3436.

Mitragyna parviflora Korth. Planted as avenue tree near Alagar Temple, in flower (14-6-1957), 133 M, 3499.

Morinda tinctoria Roxb. Foot of Perumalmalai near Alagar Hills, common, in flower and fruit (15-6-1957), 83 M, 3509.

Oldenlandia corymbosa Linn. On the road to Nupuraganga from Alagar Temple, common, in flower and fruit (11-6-1957), 267 M, 3392.

Oldenlandia herbacea (Linn.) Roxb. On the road to Nupuraganga from Alagar Temple, common, in flower and fruit (11-6-1957), 267 M, 3397, 3502.

Oldenlandia umbellata Linn. In fields around Poyakarai Pond near Alagar Hills, common, in flower and fruit (12-6-1957), 133 M, 3430.

Psychotria subintegra Hk.f. Peria-aruvi, Alagar Hills, common, in flower and fruit (16-2-1957), 266 M, 5335.

Randia brandisii Gamble n.c. Peria-aruvi, Alagar Hills, common, in flower (13-6-1957), 333 M, 3473.

Randia dumetorum Lamk. Foot of Alagar Hills, very common, in flower (10-6-1957), 167 M, 3094.

Randia malabarica Lamk. Foot of Alagar Hills, common, in flower (10-6-1957), 167 M, 3353.

Tarennia asiatica (Linn.) O. Ktz. Foot of Alagar Hills, common, in flower (10-6-1957), 167 M, 3350.

COMPOSITÆ

Blumea obliquea (Linn.) Druce. In paddy fields around Poyakarai Pond near Alagar Hills, common, in flower and fruit (12-6-1957), 133 M, 3437.

Blumea mollis (D. Don.) Merr. On the road to Peria-aruvi, Alagar Hills, common, in flower (21-4-1958), 233 M, 5729.

Blumea virens DC. Karandamalais near Natham, common, in flower (15-2-1958), 366 M, 5325.

Eclipta prostrata Linn. Peria-aruvi, Alagar Hills, common, in flower and fruit (13-6-1957), 300 M, 3466.

Gnaphalium indicum Linn. Near Munnur Rest House, Alagar Hills, common, in flower (14-2-1957), 133 M, 5299.

Lactuca hastata DC. Karandamalais, common, in flower (22-4-1958), 500 M, 5742.

Lactuca runcinata DC. On the road to Karandamalais from Natham, common, in flower and fruit (15-2-1958), 200 M, 5305.

Notonia grandiflora DC. Around Vemburuli on the Natham-Madurai Road, common, in flower (12-6-1957), 233 M, 3457.

Sphaeranthus indicus Linn. In paddy fields around Vemburuli on the Natham-Madurai Road, common, in flower (12-6-1957), 233 M, 3455.

Tithonia diversifolia A. Gray. Around Alagar Temple, common, in flower (14-6-1957), 133 M, 3486.

Tridax procumbens Linn. On the Natham-Madurai Road, common, in flower and fruit (21-4-1958), 200 M, 5720.

Vernonia cinerea Less. On the road to Nupuraganga from Alagar Temple, common, in flower and fruit (11-6-1957), 267 M, 3399.

Vicoa indica (Willd.) DC. In the crevices of steps leading to Poyakarai Pond near Alagar Hills, common, in flower (12-6-1957), 133 M, 3428.

Wedelia calendulacea Less. Periathopu near Allampatti, Melur Taluk, common, in flower (21-9-1957), 133 M, 4317.

SPHENOCLEACEÆ (= CAMPANULACEÆ B.H.)

Sphenoclea zeylanica Gaertn. In a tank at Kallandiri near Alagar Hills, common, in flower and fruit (23-9-1957), 83 M, 4347.

OLEACEÆ

- * *Jasminum angustifolium* Vahl. On the way to Peria-aruvi, Alagar Hills, common, in flower (21-4-1958), 200 M, 5734.
- * *Jasminum sessiliflorum* Vahl. Foot of Alagar Hills, common, in flower (10-6-1957), 167 M, 3361, 3377.
- Jasminum trichotomum* Heyne. Foot of Alagar Hills, common, in flower (10-6-1957), 167 M, 3096.

SALVADORACEÆ

- Azima tetracantha* Lamk. Around Alagar Temple, common, in flower (14-6-1957), 133 M, 3496.

APOCYNACEÆ

- Aganosma cymosa* Don. On the way to Nupuraganga from Alagar Temple, common, in flower (19-9-1957), 333 M, 4263.
- Carissa spinarum* Linn. Periathopu near Allampatti, Melur Taluk, common, in flower (21-9-1957), 133 M, 4314.
- Ichnocarpus frutescens* R. Br. Peria-aruvi, Alagar Hills, common, in flower (22-9-1957), 333 M, 4343.
- Lochnera pusilla* (Murr.) Schum. In cultivated fields on the way to Poyakarai, Alagar Hills, common, in flower and fruit (20-9-1957), 133 M, 4285.
- * *Vallisneria spiralis* (L.) O. Ktze. On the road to Nupuraganga from Alagar Temple, few, in flower (11-6-1957), 333 M, 3413.
- * *Wrightia tinctoria* R. Br. On the road to Peria-aruvi, Alagar Hills, common, in flower (21-4-1958), 233 M, 5728.

ASCLEPIADACEÆ

- Calotropis gigantea* R. Br. At Kallandiri near Alagar Hills, common, in flower (23-9-1957), 83 M, 4349.
- Ceropegia tuberosa* Roxb. Karandamalais, common, in flower and fruit (15-2-1958), 366 M, 5322.
- Gymnema elegans* W. & A. On the way to Peria-aruvi, Alagar Hills, common, in flower (22-9-1957), 266 M, 4336.
- Gymnema montanum* Hk. f. Allampatti on the Alagar Temple-Melur Road, common, in flower (21-9-1957), 75 M, 4311.
- Marsdenia volubilis* (Linn.f.) Cooke. Foot of Perumalmalai near Alagar Hills, common, in flower (23-9-1957), 83 M, 4351.
- Pergularia daemia* (Forsk.) Chiov. Foot of Alagar Hills, common, in flower (10-6-1957), 167 M, 3093.

Sarcostemma acidum (Roxb.) Voigt. Foot of Perumalmalai near Alagar Hills, common, in flower (23-9-1957), 83 M, 4352.

Secamone emetica R. Br. Foot of Alagar Hills, common, in flower (10-6-1957), 167 M, 3372, 4250.

Tylophora indica (Burm.f.) Merr. Allampatti on the Alagar Temple-Melur Road, common, in flower and fruit (21-9-1957), 75 M, 4313.

LOGANIACEÆ

Strychnos nux-vomica Linn. Peria-aruvi, Alagar Hills, common, in flower and fruit (21-4-1958), 200 M, 5733.

GENTIANACEÆ

Canscora sessiliflora R. & S. In moist places around Nallakolam, Cheegapatti near Alagar Hills, common, in flower (14-2-1958), 200 M, 5289.

Enicostemma verticillatum (Linn.) Engl. Foot of Alagar Hills, common, in flower (10-6-1957), 167 M, 3365.

HYDROPHYLLACEÆ

Hydrolea zeylanica Vahl. In a small pond at Kallandiri near Alagar Hills, common, in flower (14-2-1958), 100 M, 5295.

BORAGINACEÆ

Coldenia procumbens Linn. On the bank of Poyakarai Pond, Alagar Hills, common, in flower and fruit (12-6-1957), 133 M, 3442.

Ehretia microphylla Lamk. Foot of Alagar Hills, common, in flower (10-6-1957), 167 M, 3095.

Heliotropium indicum Linn. Along roadside at Vemburuli on the Natham-Madurai Road, common, in flower and fruit (12-6-1957), 233 M, 3459.

Heliotropium scabrum Retz. Foot of Perumalmalai near Alagar Hills, common, in flower (15-6-1957), 83 M, 3505.

CONVOLVULACEÆ

Evolvulus alsinoides Linn. Near Chenthurai at the foot of Karandamalais, common, in flower and fruit (22-4-1958), 266 M, 5737.

* *Hewittia sublobata* (Linn.f.) O. Kuntze. Peria-aruvi, Alagar Hills, common, in flower (16-2-1958), 266 M, 5332.

Ipomoea obscura Ker-Gawl. Near Chettiyarpatti on the Alagar Temple-Melur Road, common, in flower (21-9-1957), 75 M,

4303; On the road to Karandamalais from Natham, common, in flower (15-2-1958), 200 M, 5307.

Ipomoea pes-caprae (Linn.) Sweet. At Parali on the Madurai-Natham Road, common, in flower (14-2-1958), 200 M, 5300.

Ipomoea staphylina R. & S. On the road to Alagar Hills from Natham, common, in flower (14-2-1958), 200 M, 5282.

Merremia tridentata (Linn.) Hall f. Near Allampatti, on the Alagar Temple-Melur Road, common, in flower and fruit (21-9-1957), 75 M, 4310.

* *Rivea hypocrateriformis* Choisy. Foot of Alagar Hills, common, in flower and fruit (17-2-1958), 133 M, 5339.

SOLANACEÆ

Solanum pubescens Willd. Foot of Alagar Hills, common, in flower and young fruit (10-6-1957), 167 M, 3348.

Solanum trilobatum Linn. On the road to Karandamalais from Natham, common, in flower and fruit (15-2-1958), 200 M, 5309.

SCROPHULARIACEÆ

* *Bacopa monnieri* (Linn.) Pennell. Poyakarai Pond near Alagar Hills, very common, in flower (12-6-1957), 133 M, 3426.

* *Dopatrium lobelioides* Benth. In paddy fields at Oomatchikolam on the Madurai-Natham Road, abundant, in flower (22-9-1957), 66 M, 4326.

Glossostigma spathulatum Arn. Nallakolam, Cheegapatti near Alagar Hills, common, in flower and fruit (14-2-1958), 200 M, 5284.

Limnophila indica (Linn.), Druce. In a small pond near Forest Experimental Station, Vemburuli on the Natham-Madurai Road, common, in flower and fruit (12-6-1957), 233 M, 3458.

Lindernia anagallis (Burm.) Pennell. In a small stream on the road to Nupuraganga from Alagar Temple, common, in flower and fruit (11-6-1957), 267 M, 3388.

Lindernia parviflora (Roxb.) Haines. In paddy fields around Vemburuli on the Natham-Madurai Road, common, in flower and fruit (12-6-1958), 233 M, 3461, 4329.

Scoparia dulcis Linn. On the road to Nupuraganga from Alagar Temple, common, in flower and fruit (11-6-1957), 267 M, 3390.

Stemodia viscosa Roxb. In paddy fields around Poyakarai pond near Alagar Hills, common, in flower (12-6-1957), 133 M, 3438.

Striga asiatica (Linn.) O. Kuntze. In cultivated fields, growing parasitically on the roots of *Sorghum vulgare*, on the way to Poyakarai, Alagar Hills, common, in flower and fruit (20-9-1957), 133 M, 4274.

Striga euphrasioides Benth. In dry open fields at Cheegapatti near Alagar Hills, common, in flower (14-2-1958), 200 M, 5287.

BIGNONIACEÆ

Stereospermum personatum (Hassk.) Chatt. On the road to Nupuraganga from Alagar Temple, common, in flower (11-6-1957), 333 M, 3414.

PEDALIACEÆ

Martynia annua Linn. In cultivated fields around Poyakarai, Alagar Hills, common, in flower and fruit (20-9-1957), 133 M, 4286.

Pedaliium murex Linn. Around Alagar Temple, common, in flower (14-6-1957), 133 M, 3493.

ACANTHACEÆ

Adhatoda vasica Nees. Alagar Temple Garden, cultivated, in flower (19-2-1958), 233 M, 5372.

Andrographis echioides Nees. In cultivated fields on the way to Poyakarai, Alagar Hills, common, in flower and fruit (20-9-1957), 133 M, 4283.

Asteracantha longifolia (Linn.) Nees. In a tank at Kallandiri near Alagar Hills, common, in flower (23-9-1957), 83 M, 4345.

Asystasia gangetica T. And. Road side at Vemburili on the Natham-Madurai Road, common, in flower (12-6-1957), 233 M, 3463.

Barleria acuminata Wt. Karandamalais, common, in flower and fruit (15-2-1958), 366 M, 5323.

Barleria longiflora Linn.f. Foot of Alagar Hills, common, in flower and fruit (17-2-1958), 133 M, 5350.

Barleria nitida Nees. Foot of Alagar Hills, common, in flower and fruit (17-2-1958), 133 M, 5349.

Barleria noctiflora Linn.f. Around Munnur Rest House, Alagar Hills, very common, in flower and fruit (14-6-1957), 133 M, 3501.

* *Blepharis maderaspatensis* (Linn.) Heyne ex Roth. Peria-aruvi, Alagar Hills, common, in flower (16-2-1958), 266 M, 5330.

- Dicliptera cuneata* Nees. Nupuraganga, Alagar Hills, common, in flower (19-9-1957), 467 M, 4265; Foot of Karandamalais, common, in flower and fruit (15-2-1958), 333 M, 5314.
- * *Elytraria acaulis* (Linn.f.) Lindan. In fields around Poyakarai Pond near Alagar Hills, common, in flower and fruit (12-6-1957), 133 M, 3435.
- Justicia gendarussa* Linn.f. Along a stream by the side of the road to Nupuraganga from Alagar Temple, common, in flower (11-6-1957), 267 M, 3408.
- Justicia glauca* Rottl. In cultivated fields on the way to Poyakarai, Alagar Hills, common, in flower and fruit (20-9-1957), 133 M, 4273.
- Monothecium aristatum* T. And. Karandamalais, common, in flower (15-2-1958), 366 M, 5326.
- Phaulopsis dorsiflora* (Retz.) Santapau. Peria-aruvi, Alagar Hills, common, in flower and fruit (16-2-1958), 266 M, 5327.
- Pseuderanthemum malabaricum* (Cl.) Gamble n.c. Peria-aruvi, Alagar Hills, common, in flower and fruit (16-2-1958), 266 M, 5329.
- Rhinacanthus nasuta* (Linn.) Kurz. Karandamalais, near Alagar Hills, common, in flower (15-2-1958), 333 M, 5317.
- * *Stenosiphonium russelianum* Nees. Foot of Alagar Hills, common, in flower and fruit (17-2-1958), 133 M, 5348.

VERBENACEÆ

- Clerodendrum inerme* Gaertn. Malayalathampatti near Kallandiri, Alagar Hills, common, in flower (23-9-1957), 83 M, 4354.
- Gmelina asiatica* Linn. Foot of Alagar Hills, common, in flower and fruit (10-6-1957), 167 M, 3355.
- Lantana camara* Linn. var. *aculeata* (Linn.) Moldenke. On the way to Karandamalais from Natham, common, in flower and fruit (15-2-1957), 200 M, 5303.
- Phyla nodiflora* (Linn.) Green. Poyakarai Pond, Alagar Hills, common, in flower (12-6-1957), 133 M, 3427.
- Premna corymbosa* Rottl. & Willd. Foot of Alagar Hills, few, in flower (10-6-1957), 133 M, 3373.
- Premna serratifolia* Linn. Foot of Alagar Hills, common, in flower (10-6-1957), 133 M, 3352.
- Premna tomentosa* Willd. Peria-aruvi, Alagar Hills, common, in flower and young fruit (13-6-1957), 267 M, 3471.

Priva cordifolia (Linn.f.) Druce. Nupuraganga, Alagar Hills, common, in flower and fruit (19-2-1958), 333 M, 5380.

Symphorema involucratum Roxb. Peria-aruvi, Alagar Hills, common, in flower and fruit (21-4-1958), 333 M, 5730.

Vitex altissima Linn.f. On the road to Nupuraganga from Alagar Temple, few, in flower (11-6-1957), 333 M, 3417, 4257.

LABIATÆ

Anisomeles malabarica R. Br. Around Alagar Temple, common, in flower (14-6-1957), 133 M, 3494.

Geniosporum prostratum Benth. In moist places around Nallakolam, Cheegapatti near Alagar Hills, common, in flower (14-2-1958), 200 M, 5292.

Leonotis nepetaefolia R. Br. Along the road to Karandamalais from Natham, common, in flower and fruit (15-2-1958), 200 M, 5310.

Leucas aspera Spreng. In paddy fields of the Natham-Madurai Road, common, in flower and fruit (21-4-1958), 200 M, 5723.

Leucas lavandulaefolia Rees. In dry open fields around Cheegapatti near Alagar Hills, common, in flower (14-2-1957), 200 M, 5294.

Ocimum americanum Linn. Pulakolam near Kaverichettipatti on the Natham-Dindigul Road, abundant, in flower and fruit (20-2-1958), 233 M, 5384.

Ocimum sanctum Linn. Cultivated in Alagar Temple garden, in flower and fruit (14-6-1957), 133 M, 3492.

NYCTAGINACEÆ

Boerhaavia diffusa Linn. In fields around Poyakarai Pond near Alagar Hills, common, in flower (12-6-1957), 133 M, 3434.

**Pisonia aculeata* Linn. On the road to Karandamalais from Natham, common, in flower (15-2-1958), 200 M, 5311 (Male); Peria-aruvi, Alagar Hills, common, in flower and fruit (16-2-1958), 266 M, 5334 (Female).

AMARANTHACEÆ

Achyranthes aspera Linn. On the road to Karandamalais from Natham, common, in flower and fruit (15-2-1958), 200 M, 5306.

Aerva lanata Juss. On the way to Poyakarai, Alagar Hills, common, in flower (20-9-1957), 133 M, 4302.

Allmania nodiflora R. Br. var. *aspera* Hk.f. Along the bank of a channel near Vemburuli on Natham-Madurai Road, common, in flower (12-6-1957), 267 M, 3453, 4277.

- Alternanthera sessilis* (Linn.) R. Br. Along margin of Poyakarai Pond near Alagar Hills, common, in flower (12-6-1957), 133 M, 3444, 4350.
- Amaranthus viridis* Linn. On the way to Nupuraganga from Alagar Temple, common, in flower and fruit (11-6-1957), 200 M, 3386, 4342.
- Celosia argentea* Linn. In paddy fields on the Natham-Madurai Road, common, in flower and fruit (21-4-1958), 200 M, 5721.
- Celosia polygonoides* Retz. Near Alagar Temple, common, in flower (14-6-1957), 133 M, 3491.
- Digera muricata* (Linn.) Mart. At Kallandiri near Alagar Hills, common, in flower and fruit (20-9-1957), 83 M, 4297.
- Gomphrena decumbens* Jacq. On the way to Nupuraganga from Alagar Temple, common, in flower (11-6-1957), 200 M, 3382.
- Nothosaerva brachiata* Wt. On the way to Nupuraganga from Alagar Temple, common, in flower (19-2-1958), 233 M, 5371.
- Pupalia atropurpurea* Moq. On the road to Karandamalais from Natham, common, in flower and fruit (15-2-1958), 200 M, 5308.

BASELLACEÆ (= CHENOPODIACEÆ B.H.)

- Basella rubra* Linn. Karandamalais, common, in flower (15-2-1958), 366 M, 5324.

POLYGONACEÆ

- Polygonum glabrum* Willd. In a channel near Poyakarai, Alagar Hills, common, in flower (12-6-1957), 133 M, 3441.

ARISTOLOCHIACEÆ

- Aristolochia bracteata* Retz. Near Chettiarpatti, on the Alagar Temple-Melur Road, common, in flower and fruit (21-9-1957), 75 M, 4304.

PIPERACEÆ

- Piper hymenophyllum* Miq. Karandamalais, common, in fruit (22-4-1958), 500 M, 5746.
- Piper longum* Linn. Alagar Temple garden, cultivated, in flower (14-6-1957), 167 M, 3489.

LAURACEÆ

- Cassytha filiformis* Linn. Foot of Alagar Hills, common, in flower (10-6-1957), 167 M, 3097.

Litsea glutinosa (Lour.) C. B. Robinson. On the road to Nupuraganga from Alagar Temple, common, in flower (11-6-1957), 267 M, 3419.

HERNANDIACEÆ (= COMBRETACEÆ B.H.)

Gyrocarpus americanus Jacq. Karandamalais, abundant, in flower (15-2-1958), 266 M, 5313.

LORANTHACEÆ

Dendrophthoe falcata (Linn.f.) Etting. On the way to Nupuraganga from Alagar Temple, common, in flower (19-2-1958), 233 M, 5375.

Taxillus heyneanus (Schult.) Danser. Foot of Alagar Hills, common, in flower (18-9-1957), 167 M, 4249.

Viscum capitellatum Sm. Peria-aruvi, Alagar Hills, common, in flower and fruit (21-4-1957), 333 M, 5732.

EUPHORBIACEÆ

Acalypha alnifolia Klein ex Willd. On the way to Nupuraganga from Alagar Temple, abundant, in flower (11-6-1957), 267 M, 3384, 4315.

Acalypha indica Linn. Around Alagar Temple, common, in flower and fruit (14-6-1957), 167 M, 3487.

Acalypha lanceolata Willd. At Kallandiri near Alagar Hills, common, in flower and fruit (20-9-1957), 83 M, 4298.

Actephila excelsa Muell-Arg. Karandamalais, few, in flower and fruit (22-4-1958), 500 M, 5750.

Antidesma zeylanicum Lamk. Near Nupuraganga, Alagar Hills, few, in flower and fruit (19-9-1957), 433 M, 4268.

**Cleidion spiciflorum* (Burm.) Merrill. Karandamalais, few, in fruit (22-4-1958), 500 M, 5749.

Cleistanthus collinus Benth. On the road to Peria-aruvi, Alagar Hills, common, in flower (21-4-1958), 5727, 5761.

Croton bonplandianum Baill. Around Alagar Temple, abundant, in flower and fruit (14-6-1957), 167 M, 3495.

Euphorbia bombaiensis Santapau. Around Poyakarai Pond, Alagar Hills, common, in flower and fruit (20-9-1957), 133 M, 4289.

Euphorbia heterophylla Linn. Along the road to Natham from Madurai, common, in flower and fruit (19-2-1958), 200 M, 5382.

- Euphorbia hirta* Linn. On the road to Nupuraganga from Alagar Temple and around Poyakarai Pond, Alagar Hills, very common, in flower (11-6-1957), 467 M, 3378.
- Gelonium lanceolatum* Willd. Along the road to Nupuraganga from Alagar Temple, common, in flower and fruit (11-6-1957), 200 M, 3395; 3401.
- Givotia rottleriformis* Griff. On the way to Nupuraganga from Alagar Temple, common, in flower (11-6-1957), 200 M, 3409.
- Glochidion zeylanicum* A. Juss. Peria-aruvi, Alagar Hills, few, in flower and fruit (13-6-1957), 333 M, 3478.
- Jatropha curcas* Linn. On the road to Nupuraganga from Alagar Temple, common, in flower (11-6-1957), 267 M, 3400.
- Jatropha gossypifolia* Linn. Foot of Alagar Hills, very common, in flower (10-6-1957), 200 M, 3100.
- Kirganelia reticulata* (Poir.) Baill. Along the road to Nupuraganga from Alagar Temple, common, in flower and fruit (11-6-1957), 267 M, 3391.
- Mallotus muricatus* Bedd. Along the road to Nupuraganga from Alagar Temple, common, in flower and fruit (11-6-1957), 267 M, 3406, 3407.
- Mallotus philippensis* Muell-Arg. Peria-thopu near Allampatti, Melur Taluk, in flower (21-9-1957), 200 M, 4320.
- Melanthesa turbinata* (Koen. ex Roxb.) Oken. Foot of Alagar Hills, common, in flower (10-6-1957), 167 M, 3366.
- Phyllanthus niruri* Linn. On the road to Nupuraganga from Alagar Temple, common, in flower and fruit (11-6-1957), 267 M, 3379.
- Phyllanthus urinaria* Linn. Peria-aruvi, Alagar Hills, common, in flower and fruit (22-9-1957), 333 M, 4338.
- Sebastiania chamaelea* Muell-Arg. In cultivated fields on the way to Poyakarai, Alagar Hills, common, in flower and fruit (20-9-1957), 133 M, 4282; 5338.
- Tragia bicolor* Miq. By the side of a stream at Peria-thopu near Allampatti, Melur Taluk, common, in flower and fruit (21-9-1957), 167 M, 4325.

ULMACEÆ (= URTICACEÆ B.H.)

- Celtis wightii* Planch. Foot of Alagar Hills, few, in flower and young fruit (10-6-1957), 167 M, 3369.

Holoptelea integrifolia Planch. On the road to Peria-aruvi, Alagar Hills, common, in fruit (21-4-1958), 200 M, 5725.

Trema orientalis Bl. Karandamalais near Natham, common, in flower and fruit (15-2-1958), 333 M, 5319.

MORACEÆ (= URTICACEÆ B.H.)

**Artocarpus hirsuta* Lamk. On the way to Nupuraganga, Alagar Hills, in flower (23-4-1958), 367 M, 5755.

Ficus glomerata Roxb. On the road to Nupuraganga from Alagar Temple, common, in flower and fruit (11-6-1957), 267 M, 3403.

Ficus mysorensis Heyne. Peria-aruvi, Alagar Hills, few, in flower and fruit (13-6-1957), 333 M, 3476.

Ficus retusa Linn. Near Nupuraganga, Alagar Hills, common, in flower and fruit (19-9-1957), 433 M, 4267.

Phyllochlamys spinosa Bur. On the road to Nupuraganga from Alagar Temple, common, in flower (11-6-1957), 267 M, 3405.

HYDROCHARITACEÆ

Lagarosiphon alternifolius (Roxb.) Druce. In a small pond at Kallandiri, Alagar Hills, very common, in flower (20-9-1957), 83 M, 4295 (Male); 4344 (Female).

Ottelia alismoides Pers. Poyakarai Pond near Alagar Hills, abundant, in flower (12-6-1957), 133 M, 3420.

ORCHIDACEÆ

Acampe præmorsa Blatter & McCann. Peria-aruvi, Alagar Hills, common, in flower and fruit (13-6-1957), 333 M, 3482.

AMARYLLIDACEÆ

Agave sisalana Pers. On the road to Nupuraganga from Alagar Temple, common, in flower (19-9-1957), 200 M, 4259.

DIOSCOREACEÆ

**Dioscorea hispida* Dennst. Peria-aruvi, Alagar Hills, very common, in flower (22-9-1957), 333 M, 4341.

Dioscorea tomentosa Heyne. On the way to Peria-aruvi, Alagar Hills, common, in flower (22-9-1957), 266 M, 4332 (Female); 4333 (Male).

LILIACEÆ

Gloriosa superba Linn. Periathopu near Allampatti, Melur Taluk, common, in flower and fruit (21-9-1957), 133 M, 4316.

- Sansevieria roxburghiana* Schult.f. Foot of Perumalmalai near Alagar Hills, common, in flower (15-6-1957), 133 M, 3511.
- Scilla indica* Baker. In cultivated fields on the way to Poyakarai, Alagar Hills, common, in flower (20-9-1957), 133 M, 4278.
- **Urginea coromandeliana* Hk.f. Kadoor near the foot of Alagar Hills, common, in flower and fruit (23-4-1958), 166 M, 5752.

PONTEDERIACEÆ

- Eichhornia crassipes* Solms. In a small puddle near Kallandiri on the way to Alagar Temple, very common, in flower (15-6-1957), 83 M, 3512.
- Monochoria hastaeifolia* Presl. In a small pond at Kallandiri near Alagar Hills, very common, in flower (20-9-1957), 83 M, 4294.
- Monochoria vaginalis* Presl. In a channel near Vemburuli on the Natham-Madurai Road, common, in flower (12-6-1957), 233 M, 3452.

XYRIDACEÆ

- Xyris pauciflora* Willd. In moist places around Nallakolam, Cheegapatti near Alagar Hills, common, in flower (14-2-1958), 200 M, 5288.

COMMELINACEÆ

- Aneilema montanum* Wt. Peria-aruvi, Alagar Hills, common, in flower and fruit (16-2-1958), 266 M, 5331.
- Cyanotis axillaris* R. & S. Around Nallakolam, Cheegapatti near Alagar Hills, common, in flower—violet coloured—and fruit (14-2-1958), 200 M, 5285; Pulakolam, near Kaverichettipatti on Natham-Dindigul Road, common, in flower—white coloured—and fruit (20-2-1958), 233 M, 5387.
- Murdannia dimorphum* (Dalz.) Bruckner. In moist places around Nallakolam, Cheegapatti near Alagar Hills, common, in flower and fruit (14-2-1958), 200 M, 5290.

TYPHACEÆ

- Typha angustata* Bory & Chaub. Peria-aruvi, Alagar Hills, common, in flower and fruit (13-6-1957), 167 M, 3468.

LEMNACEÆ

- Lemna paucicostata* Hegelm. In a small puddle near Kallandiri on the road to Alagar Temple, common, in vegetative condition only (15-6-1957), 83 M, 3513.

- Wolffia arrhiza* Wimm. In a tank close to Alagar Temple, abundant, only in vegetative condition (14-6-1957), 167 M, 3498.

ALISMACEÆ

- Limnophyton obtusifolium* Miq. Pulakolam near Kaverichettipatti on Natham-Dindigul Road, abundant, in flower (20-2-1957), 233 M, 5385.

APONOGETONACEÆ (= NAIADACEÆ B.H.)

- Aponogeton natans* Engl. & Kr. In a pond at Oomatchikolam on Madurai-Natham Road, common, in flower (22-9-1957), 66 M, 4328.

POTAMOGETONACEÆ (= NAIADACEÆ B.H.)

- Potamogeton indicus* Roxb. Poyakarai Pond near Alagar Hills, common, in flower (12-6-1957), 133 M, 3443.

ERIOCAULACEÆ

- Eriocaulon quinquangulare* Linn. Nallakolam, Cheegapatti near Alagar Hills, common, in flower (14-2-1958), 200 M, 5283.

CYPERACEÆ

- Bulbostylis barbata* Kunth. Near Allampatti on the Alagar Temple-Melur Road, very common, in flower and fruit (21-9-1957), 75 M, 4306.

- **Cyperus articulatus* Linn. Poyakarai Pond near Alagar Hills, common, in flower (12-6-1957), 133 M, 3424.

- **Cyperus compressus* Linn. In fields around Poyakarai Pond, Alagar Hills, common, in flower (12-6-1957), 133 M, 3432.

- Cyperus difformis* Linn. In paddy fields around Vemburuli on Madurai-Natham Road, common, in flower (12-6-1957), 233 M, 3462; In a pond at Kallandiri near Alagar Hills, very common, in flower (20-9-1957), 83 M, 4296.

- Cyperus distans* Linn.f. On the road to Nupuraganga from Alagar Temple in moist shady places, common, in flower (11-6-1957), 200 M, 3411.

- Cyperus eleusinoides* Kunth. Near a stream at Karandamalais, common, in flower (22-4-1958), 500 M, 5747.

- **Cyperus exaltatus* Retz. Poyakarai Pond near Alagar Hills, common, in flower (12-6-1957), 133 M, 3423, 4241.

- Cyperus kyllingia* Endl. On the road to Nupuraganga from Alagar Temple, common, in flower (11-6-1957), 300 M, 3412.
- Cyperus rotundus* Linn. In fields around Poyakarai Pond near Alagar Hills, common, in flower (12-6-1957), 133 M, 3431, 3467.
- Cyperus tenuispica* Steud. In a paddy field near Vemburuli on Madurai-Natham Road, common, in flower (12-6-1957), 233 M, 3451, 4327.
- **Eleocharis atropurpurea* Kunth. Poyakarai Pond near Alagar Hills, common, in flower (12-6-1957), 133 M, 3445.
- Fimbristylis argentea* Vahl. On the road to Nupuraganga from Alagar Temple, common, in flower and fruit (11-6-1957), 200 M, 3389.
- Fimbristylis dichotoma* Vahl. Foot of Alagar Hills, common, in flower (10-6-1957), 200 M, 3367.
- Fimbristylis ferruginea* Vahl. By the side of a stream near Vadipatti on the road to Madurai from Dindigul, common, in flower (17-9-1957), 167 M, 4239.
- Fimbristylis miliacea* Vahl. In a pond near Vadipatti on the road to Madurai from Dindigul, common, in flower (17-9-1957), 167 M, 4236, 4330.
- Fimbristylis monostachya* Hassk. Foot of Alagar Hills, common, in flower (18-9-1957), 167 M, 4254.
- Fimbristylis quinquangularis* Kunth. Periathopu near Allampatti, Melur Taluk, common, in flower (21-9-1957), 167 M, 4322.
- Fimbristylis spathacea* Roth. On a roadside stream near Appanthirupathi along the road to Alagar Temple, common, in flower (20-9-1957), 83 M, 4301.
- **Fuirena glomerata* Lam. Near Vemburuli on Natham-Madurai Road, common, in flower (12-6-1957), 233 M, 3454, 4356.
- Lipocarpa triceps* Nees. In moist places around Nallakolam, Cheegapatti near Alagar Hills, common, in flower (14-2-1958), 200 M, 5291.
- **Scirpus articulatus* Linn. In a small pond near Forest Experimental Station, Vemburuli on Madurai-Natham Road, common, in flower and fruit (12-6-1957), 233 M, 3456.
- Scirpus jacobii* Fisch. Pulakolam near Kaverichettipatti on Natham-Dindigul Road, abundant, in flower and fruit (20-2-1958), 233 M, 5386.
- Scirpus squarrosus* Linn. Along the border of Perumal Koil Tank at the foot of Perumalmalai near Alagar Hills, abundant, in flower (15-6-1957), 133 M, 3510.

Scirpus supinus Linn. Poyakarai Pond near Alagar Hills, abundant, in flower (12-6-1957), 133 M, 3421.

Scleria corymbosa Roxb. By the side of a stream, Peria-aruvi, Alagar Hills, common, in flower (22-9-1957), 333 M, 4340.

GRAMINEÆ

Aristida setacea Retz. Kallandiri near Alagar Hills, common, in flower and fruit (20-9-1957), 83 M, 4293.

Brachiaria remota Haines. Nupuraganga, Alagar Hills, common, in flower (19-9-1957), 467 M, 4266.

Cyrtococcum trigonum A. Camus. On the way to Nupuraganga, Alagar Hills, common, in flower (23-4-1958), 467 M, 5756.

Echinochloa colona Link. Peria-aruvi, Alagar Hills, common, in flower (13-6-1957), 267 M, 3465, 4237.

Eragrostis gangetica Steud. Forest Experimental Station, Vemburuli on Natham-Madurai Road, common, in flower (12-6-1957), 233 M, 3449.

**Eragrostis japonica* Trin. On the way to Nupuraganga from Alagar Temple, common, in flower (19-9-1957), 300 M, 4262.

Eragrostis plumosa Link. On the way to Nupuraganga from Alagar Temple, common, in flower (11-6-1957), 267 M, 3385.

Eriochloa procera C.E. Hubb. By the side of a stream near Vadipatti on the road to Madurai from Dindigul, common, in flower (17-9-1957), 167 M, 4242; In a Tank at Kallandiri near Alagar Hills, common, in flower (23-9-1957), 83 M, 4346.

Isachne dispar Trin. Peria-aruvi, Alagar Hills, common, in flower and fruit (13-6-1957), 267 M, 3469.

Iseilema laxum Hack. Near Alagar Temple, common, in flower (23-9-1957), 167 M, 4357.

Leptochloa neesii (Thw.) Benth. In paddy fields at Oomatchikolam on Madurai-Natham Road, common, in flower (22-9-1957), 66 M, 4331.

Panicum repens Linn. Forest Experimental Station, Vemburuli on Natham-Madurai Road, common, in flower (12-6-1957), 233 M, 3450.

Paspalidium geminatum Stapf. By the side of a stream near Vadipatti on the road to Madurai from Dindigul, common, in flower (17-9-1957), 167 M, 4238.

Paspalum scrobiculatum Linn. Forest Experimental Station, Vemburuli on Natham-Madurai Road, common, in flower and fruit (12-6-1957), 233 M, 3448.

Perotis indica O. Kt. On the way to Poyakarai, Alagar Hills, common, in flower (20-9-1957), 133 M, 4270.

Saccharum spontaneum Linn. Along the road to Karandamalais from Natham, common, in flower (15-2-1958), 200 M, 5301.

Setaria pallidifusca Stapf. & Hubb. Near Alagar Temple, common, in flower (23-9-1957), 167 M, 4355.

Note.—Species marked with an asterisk indicate that they are new distribution to Madurai District. These data are based on a comparison with the Herbarium sheets of the Madras Herbarium, Agricultural College, Coimbatore.

ACKNOWLEDGMENT

Finally, we wish to thank Dr. J. C. Sen Gupta, Chief Botanist, Botanical Survey of India, for his keen interest and kind encouragement during the course of this work.

SUMMARY

The Alagar Hills are situated to the North-East of Madurai and consist of a couple of ridges running north to south enclosing two fertile valleys. Closely associated with these hills are the 'Natham Hills', the chief of which are the Karandamalais.

In Alagar and Natham Hills four seasonal explorations were made to the following places: Scrub jungle along the southern range of Alagar Hills, Nupuraganga, Peria-aruvi and Karandamalais.

The vegetation at the foot of these hills is of the scrub jungle type; mixed deciduous forests occur at slightly higher levels and at still higher elevations, the ever-green and grassland formations are noticed.

The plants collected are enumerated in detail. Out of the plants listed the Leguminosæ is very well represented with the largest number of genera and species, the next in order being Euphorbiaceæ and Gramineæ. The herbs and shrubs are better represented than the trees and climbers. During the four seasonal trips in these forests some species of plants were dominantly in full bloom in certain large areas of the forest. Phenological observations on these are recorded.

In the tanks, lakes and puddles around Alagar Hills and Karandamalais 49 Hydrophytes were collected. A detailed distribution of these aquatic plants in the various habitats is shown in a table.

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CYTOTAXONOMIC NOTES ON SOME ASPLENIACEAE FROM KULU VALLEY

By S. S. BIR

Department of Botany, Panjab University, Amritsar

(Received for publication on December 31, 1958)

KULU and Manali are two important towns and health resorts of Beas river valley (Kulu Valley) which lies in the main Himalayan range South-East of Kashmir. The rainfall in this region is rather low. Kulu (4,000 ft.) annually receives only about 50 inches of rain mainly during July to September and Manali is about the same. Consequently epiphytic growth, the main bulk of which is formed by ferns, is scanty in this area. This is in strong contrast to the situation at comparable altitudes in the Eastern Himalayas such as Sikkim and Darjeeling which receive more rain and harbour rich epiphytic vegetation.

Apart from classical works of Clarke (1880), Beddome (1892), Hope (1899-1904) and Marten (1909) the taxonomy of ferns of Western Himalayas has received great attention in the present century. The important and recent contributions came from Mehra (1939) and Stewart (1945, 1951). Furthermore, Schelpe (1954) made 'Ecological Observations on Pteridophyta in the Kangra Himalayas' and has listed the members occurring in various zones. However, the cytology of ferns of this region of Himalayas has not received proper attention so far. To-date a dozen species¹ have been cytologically worked out by Prof. P. N. Mehra and his students from Mussoorie, growing between 3,000-7,000 ft. altitude (Mehra and Loyal, 1956 *a, b*; Mehra and Bir, 1957, 1958; Mehra and Verma, 1957; Mehra and Gurdip Singh, 1957). This region though not as rich in Pteridophytes as the eastern part of Himalayas is, however, interesting phytogeographically because of the presence of European elements in the flora. It is likely that cytological work on the ferns of this region may clear some of the taxonomic confusions.

The writer visited the Kulu Valley in the last week of September, 1955. During this period a few members of Aspleniaceae (*sensu* Ching, 1940) were at proper stage of cytological fixation and it was thought worthwhile to undertake such a study. Fertile portions of the leaves were fixed in 1:3 acetic alcohol and acetocarmine squashes were made with usual technique. Later on, some of the material was supplemented in September, 1956 through the kindness of Mr. U. S. Srao, of Customs Department, Government of India, Amritsar, to whom I am extremely thankful for making fixations and showing keen interest.

¹ This refers only to the published work.

OBSERVATIONS

Only eight members were available for study and these belong to four different genera, namely, *Asplenium*, *Ceterach*, *Athyrium* and *Diplazium*. This is a new report of chromosome numbers for four species from India and the rest four representatives of *Asplenium* were reinvestigated from the area from cytogeographic point of view. The previous report of these latter species exists for Mussoorie area of this part of Himalayas (cf. Mehra and Bir, 1957) which is separated from Kulu by a distance of about 300 miles. In addition another West Himalayan fern, *Athyrium spectabile* (Wall.) Presl has been worked out from Mussoorie. In all the cases the meiosis is perfectly regular, producing 64 perisporiate, biplanate and apparently viable spores. The number of chiasmata varies from one to three. Apogamy or hybridity is absent.

It may be pointed out that in view of the cytological distinctness of *Diplazium* and *Athyrium* (cf. Manton and Sledge, 1954), the older suggestion of merging the two (cf. Copeland, 1947; Holttum, 1949, 1954) has been disregarded and the two have been treated as distinct genera here. Moreover, the representatives of *Athyrium* and *Diplazium* worked out here can conveniently be referred to respective genera according to their definitions given by Christensen (1938) and Ching (*loc. cit.*). These two have different basic chromosome numbers: *Athyrium*, 40 and *Diplazium*, 41.

1. *Asplenium* L.

(a) *Asplenium dalhousie* Hook.² (= *A. alternans* Wall. Bedd. Handb. 142; *Ceterach dalhousie* (Hook.) C. Chr. and *Ceterachopsis dalhousie* Ching). Christensen (1906) transferred this species to an altogether different but allied genus *Ceterach*, which is characterised by the presence of anastomosing veinlets, abortive indusium and also by the presence of scales on the undersurface of the lobes. Even in the recent literature (Mehra, 1939; Stewart, 1945; Schelpe, 1954) the species is known as *Ceterach dalhousie* which is a misnomer. Later on, in 1940 Ching³ (*Bull. Fan. Mem. Inst. Biol. Bot. Ser.* 1940, 10: 9) founded another genus *Ceterachopsis* (J. Smith) Ching with only two representatives (cf. Ching *loc. cit.*) and based on *Ceterachopsis dalhousie* (Hook) Ching as the type species. The second and the closely similar species is *Ceterachopsis paucivenosa* Ching [= *Ceterach paucivenosa* Ching and *Asplenium paucivenosum* (Ching) Copel.] being endemic only to Eastern Himalayas and China. These two species on which the genus *Ceterachopsis* is based, though having superficial resemblance to *Ceterach officinarum* Lam. and DC. are generically different. None of the

² This name has been preferred here because the specific name 'dalhousie' has always been referred to in the existing controversy about this fern, though *A. alternans* Wall. is the oldest and valid name.

³ Not consulted in original, but information got through the kindness of Prof. R. C. Ching.

characters of *Ceterach* is present in these plants and they possess free veins, persistent indusia and glabrescent lobes.

As far as *Ceterachopsis* is concerned, it seems possible that the genus is based only on the intermediate position of its two representatives between *Asplenium* and *Ceterach* and also superficial resemblance with the latter. Moreover, the validity of *Ceterachopsis* either as a separate genus or as a synonym of *Ceterach* or *Asplenium* has not been recognised by Copeland (*loc. cit.*). These two species on which *Ceterachopsis* is based, are essentially true aspleniums. They have the same scale, sporangium and spore structure as other species of *Asplenium* (observations based on the Himalayan representatives). Anatomically too, *A. dalhousie* Hook. is similar to other species as *A. varians* (Wall.) Hook. et Grev., *A. trichomanes* L., *A. exiguum* Bedd. and *A. tenuifolium* Don, etc. (Bir, 1957).

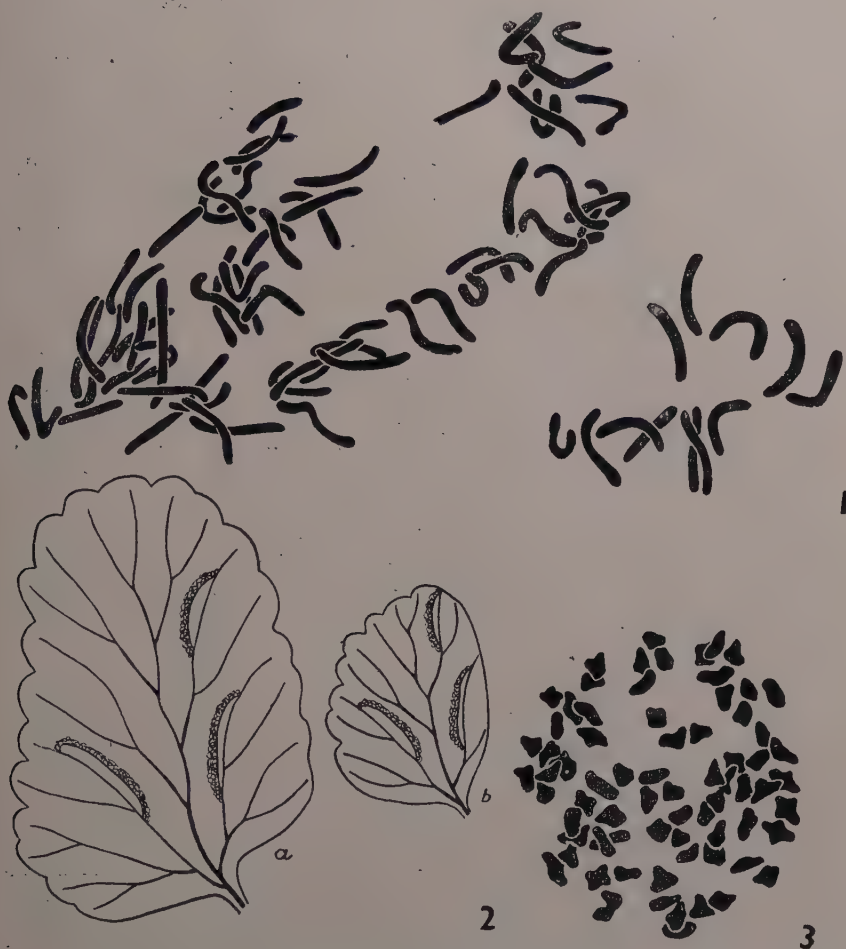
Copeland (*loc. cit.*, p. 169) while discussing *A. dalhousie* Hook. and *A. paucivenosum* (Ching) Copel. points out that "It is simply impossible to define *Asplenium* to exclude them..." and further on he continues "while I entertain no doubt as to the propriety of leaving *A. dalhousie* in *Asplenium*, its affinity to *Ceterach* is obvious and makes evident the place in *Asplenium* (*Ceterachopsis* J. Smith) from which *Ceterach* was evolved". Therefore it would not be unjustified to treat the present species as a representative of the genus *Asplenium*.

The individuals of the species grow in the crevices of rocks or masonry works between 4,000–7,000 ft. altitude (Pl. XII, Fig. 1) and are extremely common at Manali (6,000 ft.). At Kulu (4,000 ft.) they grow in shady places along with *Ceterach officinarum*. At meiosis in a large number of spore mother cells 36 bivalents have been counted; the species is a diploid (Pl. XII, Fig. 2).

(b) *Asplenium varians* (Wall.) Hook. et Grev. (= *A. fimbriatum* Kunze) and *A. exiguum* Bedd. (= *A. fontanum* Bernh. var. *exiguum* Bedd. Handb. 158). Both these species are common at Manali growing on moist shady boulders all around under coniferous forests. In *A. exiguum* adventitious buds are present terminating the main rachis. Quite often these are present on the apices of the pinnæ and those of the basal superior lobes of these pinnæ. These buds have also been reported by Mehra (*loc. cit.*) to be present on specimens collected from Mussoorie (7,000 ft.).

The size of the fronds in *A. varians* varies between 2–10". But cytologically the species is uniform and there were always found 36 bivalents in a spore mother cell. Somatic number, $2n = 72$, has been counted in a tapetal cell and is shown in Text-Fig. 1. This species like *A. dalhousie* is also a diploid.

Asplenium exiguum is a tetraploid species showing $n = 72$ at late diakinesis in a number of spore mother cells.



TEXT-FIGS. 1-3. Fig. 1. Tapetal cell from sporangium of *Asplenium varians* showing $2n = 72$, $\times 1,250$. Fig. 2. Two pinnae from large sized (a) and small sized (b) tetraploid population of *A. trichomanes*. The larger one has lower margin deeply crenated, $\times 5$. Fig. 3. A spore mother cell showing $n = 72$ for *A. trichomanes*, $\times 1,250$.

(c) *A. trichomanes* Linn.—The individuals of this species have the same habitat as those of previous two species and colonize the moist dark rocks around Manali (6,000 ft.). The frond as well as pinna size is very different in this case. The shape of the pinnae from two variously sized individuals is different (Text-Fig. 2). The larger one has more prominently crenated lower margin. The small-sized individuals have yellowish green pinnae while the larger ones possess deep green pinnae. The individuals of both the categories of this species

grow separately in patches. However, after thorough search it is not difficult to find the intergrading types.

Only tetraploid race of the species with $n = 72$ was seen (Text-Fig. 3). The intraspecific cytological races which are reported to be present in Europe by Manton (1950) are totally absent in this area. There is no marked difference in the size of the spores and whatever little is present, may possibly be due to intrinsic factors. The small plants are similar to those occurring at Mussoorie which are also tetraploid as reported by Mehra and Bir (1957). At Simla (7,000 ft.) also this species is a tetraploid.

2. *Ceterach* Garsault

This is a very closely related genus to *Asplenium* with only three representatives throughout the world. The other two Himalayan ferns, namely, *C. dalhousie* and *C. paucivenosa* referred to this genus are true *Aspleniums* (cf. Copeland *loc. cit.* and writer's observations). It has only one representative *Ceterach officinarum* Lam. and DC. (= *Hemidictyum ceterach* Linn. Bedd. Handb. 194) in India which is distributed throughout the North-Western Himalayas from Kulu to Pahlgam, Kashmir. This is a somewhat xerophytic fern and at Kulu the plants are extremely common on exposed rocks along Kulu-Manali road. The cutting and appearance of the frond is similar to *A. dalhousie*, so without thorough examination it is difficult to separate the two. The lower surfaces of the fronds are densely covered with scales which may be deciduous at maturity. The margins of the pinna lobes curl inwards under strong conditions of desiccation.

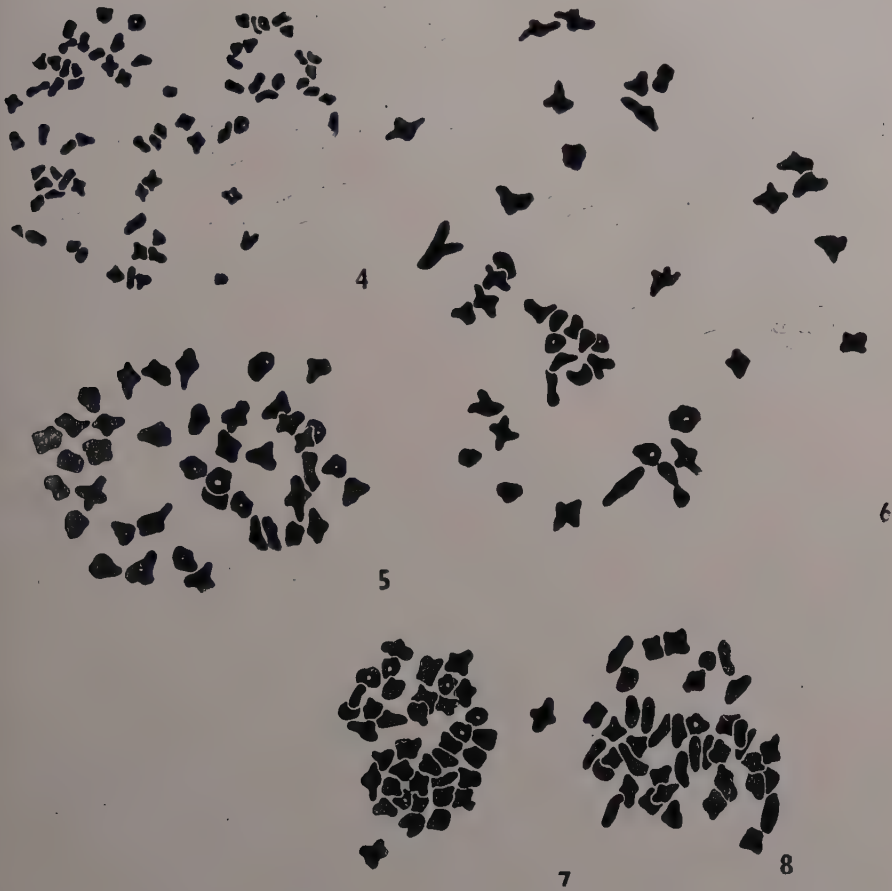
At meiosis in a spore mother cell 72 bivalents are clearly present. Thus the species is a tetraploid one based on 36 as monoploid number (Pl. XIII, Fig. 4 and Text-Fig. 4).

3. *Diplazium* Swartz

Two species namely *D. polypodioides* (Mett.) Bl. and *D. polymorphum* (Wall.) Presl. [= *D. giganteum* (Bak.) Ching] have been worked out. Both of these large-sized ferns are inhabitants of margins of water channels or extremely wet and shaded places. Schelpe's (*loc. cit.*) is the first record of *D. polymorphum* from Himalayas. It is quite common along Manali-Rohtang Pass road. The plants are tall attaining a height of up to 6 ft. and are separable from the other species by large acutely pointed and deeply crenated segments.

Diplazium polypodioides is common throughout the Kulu Valley between 4,000–8,000 ft. altitude. Recently Holttum (1954), following Raciborski¹ and the latest works of Baker and Posthumus⁴, united Blume's two species *D. polypodioides* and *D. asperum*, though earlier Clarke (*loc. cit.*), Beddome (*loc. cit.*) and Mehra (*loc. cit.*) treated them separately and v.A.v.R.⁴ had also suggested the distinctness of these two *Diplaziums*.

⁴ Not consulted in original, reference taken from Holttum (1954), *Flora of Malaya*, Part II, Ferns, p. 571.



TEXT-FIGS. 4-8. $\times 1250$. Fig. 4. Explanatory diagram to Pl. XIII Fig. 4. $n = 72$ for *Ceterach officinarum*. Fig. 5. Same as Pl. XIII Fig. 5. $n = 41$ for *Diplazium polypodioides*. Fig. 6. A spore mother cell of *Diplazium polymorphum* showing 41 bivalents. Fig. 7. Same as Pl. XII, Fig. 3 showing 40 bivalents in a spore mother cell of *Athyrium proliferum*. Fig. 8. A spore mother cell of *Athyrium spectabile* with $n = 41$.

D. polypodioides is distinct from *D. asperum* in possessing primary and secondary rachises naked, broader segments of pinnules, and spores with broad transparent perispore. While *D. asperum* as far as the present records reveal and to the writer's best knowledge does not occur in the North-Western Himalayas, it is characterized by having primary and secondary rachises densely scaly, segments narrow, toothed and deeply cut, and spores without perisporium.

Both of the species referred to here are diploid having 41 bivalents at diakinesis in a spore mother cell. One exceptionally clear preparation

of *D. polypodioides* is shown in Pl. XIII, Fig. 5 and Text-Fig. 5. The same number has also been counted for *D. polymorphum* in a number of clear preparations but unsuitable for photography and one such is represented in Text-Fig. 6. Quite often one or two pairs disjoin earlier than the remaining bivalents. *D. polypodioides* was examined from Mussoorie Hills also in September, 1952. It is also diploid like the plants of Kulu Valley.

4. *Athyrium* Roth.

(a) *Athyrium proliferum* Moore⁵ was the only representative of the genus collected as growing on somewhat moist rock alongside Kandi Pass (7,000 ft.) road which branches off from the main road to Kulu at Bajaura about 8 miles downward from Kulu. A spore mother cell at diakinesis shows 40 bivalents (Pl. XII, Fig. 3, Text-Fig. 7). The species is diploid. This is a new record of present fern from Western Himalayas. So far it was reported to grow in Ceylon only (cf. Christensen, 1906).

(b) *Athyrium spectabile* (Wall.) Presl.⁶ [Syn.: *A. (Dipl.) multicaudatum* Wall., *D. umbrosum* var. *multicaudatum* Bedd. Handb. 190]. This is one of the rarest ferns in Mussoorie and was collected only from Mossy Falls (5,000 ft.) growing in a protected place under a overhanging rock. The individuals form a large bed because of its creeping and branched rhizome. Fertile fronds are quite often uncommon and many of them have only upper pinnæ fertile.

At meiosis 41 bivalents have been counted in a number of spore mother cells (Text-Fig. 8).

If different chromosome number is the criterion for segregating members of two morphologically indistinct genera then *Athyrium spectabile* should better be called a *Diplazium* because it possesses 41 as the monoploid number. The soral structure and shape point in the same direction. This new binomial combination with full discussion will be published elsewhere.

DISCUSSION

Amongst nine members of Aspleniaceæ worked out here only three *A. trichomanes*, *A. exiguum* and *Ceterach officinarum* are tetraploids while *A. dalhousie*, *A. varians*, *D. polypodioides*, *D. polymorphum*, *Athyrium proliferum* and *A. spectabile* are diploids. Out of these two,

⁵ This species has been treated as a synonym of *Athyrium filix femina* Bernh. by Hooker and Baker (*Synopsis filicum*, London, 1874, p. 192) but exactly typical form of *A. filix-femina* has not been found in India (cf. Clarke, 1880, p. 491). Hope (1903) (*J. Bombay nat. Hist. Soc.* 14: 125-26) is of the opinion that type specimens of *filix-femina* are met within India and are identical with those of British ones. Therefore under the existing controversy this name is provisionally used here and the discussions on its validity will appear later on.

⁶ Though on the basis of soral structure one would refer it to *Diplazium*, this name has been used according to Christensen's Index (1906, p. 146).

namely, *Ceterach officinarum* and *A. trichomanes* are European elements and possess the same cytological constitution. However, it was not possible to come across the diploid race of *A. trichomanes* in the area though the size and colour difference is present. So far, only tetraploid individuals have been found from three different places in Western Himalayas, namely, Mussoorie, Simla and Manali which are separated from each other by about 150 miles. The species is well spread in the Western Himalayas and a search northwards towards Kashmir might reveal the occurrence of the diploid individuals of the species. Further, it may be pointed out that the data for the four species of *Asplenium* worked out here is the same as reported from Mussoorie by Mehra and Bir (*loc. cit.*).

The following table shows the species already worked out from Western Himalayas:—

No.	Name	Meiotic number	Grade of polyploidy	Authors
1	<i>Trichomanes insigne</i> v.d.B. var. r.	$2n=72$	8-ploid Hybrid	Mehra and Singh (1957)
2	<i>Goniopteris multilineata</i> (Wall.) Bedd.	$n=36$	Diploid	Mehra and Loyal (1956 a)
3	<i>Hypodematium crenatum</i> (Forsk.) Khun.	$n=41$	"	Mehra and Loyal (1956 b)
4	<i>Asplenium dalhousie</i> Hook. ..	$n=36$	"	Mehra and Bir (1957)
5	<i>A. varians</i> (Wall.) Hook. et Grev.	$n=36$	"	"
6	<i>A. exiguum</i> Bedd. ..	$n=72$	Tetraploid	"
7	<i>A. trichomanes</i> Linn. ..	$n=72$	"	"
8	<i>A. ensiforme</i> Wall. ..	$n=72$	"	"
9	<i>A. planicaule</i> Wall. ..	$n=72$	"	"
10	<i>Athyrium schimperi</i> Mouge ex. Fee.	$n=40$	Diploid	Mehra and Verma (1957)
11	<i>A. tenuifrons</i> (Wall.) Bedd. ..	$n=40$	"	"
12	<i>Woodwardia radicans</i> (L.) Smith ..	$n=34$	"	Mehra and Bir (1958)

The temperate climate of the Himalayas resembles with that of Europe and likewise a perusal of results for Western Himalayas show that the incidence of polyploidy is low, the diploids being in abundance and the grade of polyploidy is also restricted only to the tetraploid level in majority of the ferns of the area. It is pertinent to point out here that in Ceylon Pteridophytic flora growing under tropical conditions, species hybrids and apogamous species appear to be more frequent and the grade of polyploidy attained in many species is higher than that of species in Europe with temperate climate (*cf.* Manton, 1953). Furthermore, a comparison of results from Western Himalayas with Manton's analysis for Europe (1950) and Ceylon (1953, 1954) prove that evolution in tropics is faster than in temperate latitudes. It may also be pointed out that only one 'species hybrid' or a 'cytotype', namely, *Trichomanes*

insigne v.d.B. var. r. (cf. Mehra and Singh, 1957) has been found out from amongst Western Himalayan ferns so far worked out. Apogamy is totally absent in the members and the rest of the species are cytologically normal.

The identical monoploid number 36 for both *Asplenium* and *Ceterach* proves the close relationship of these two genera and makes it abundantly clear that here there is no usefulness of cytological data. Therefore more reliance has to be put on the morphological characters. In the present case the morphological distinctness of apparently similar members of these two genera is well established.

SUMMARY

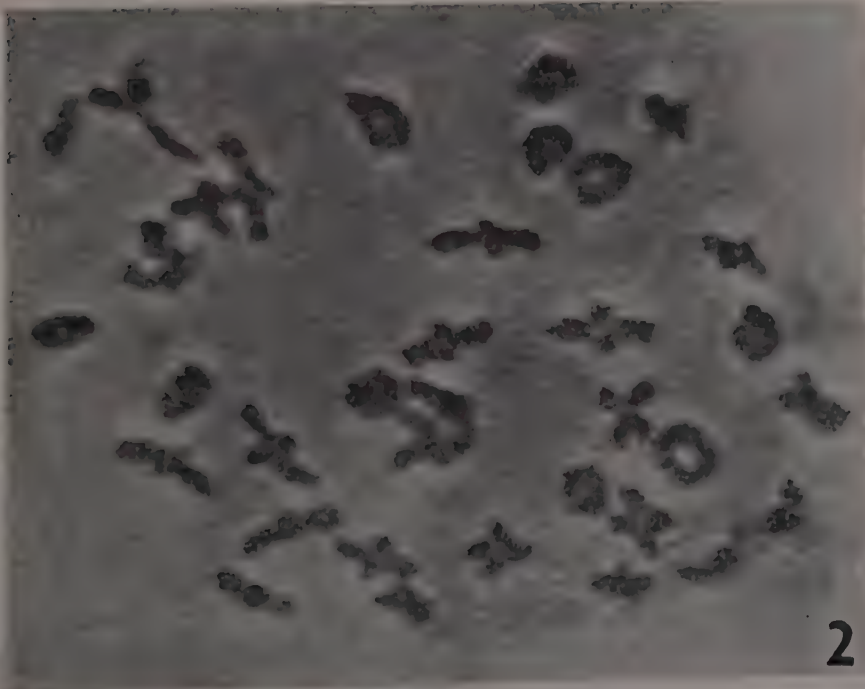
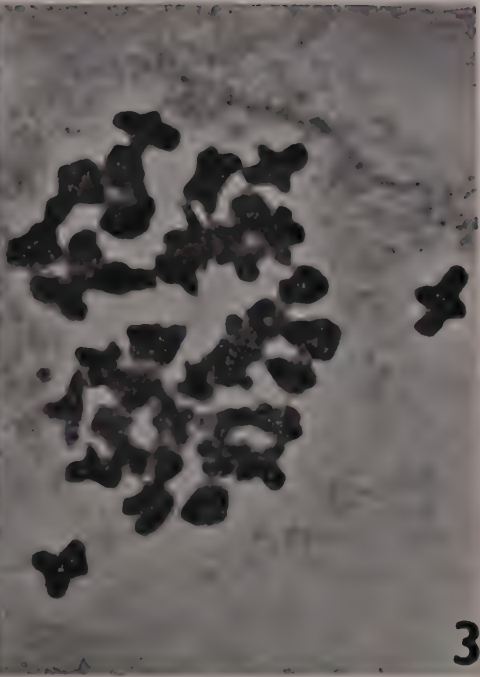
Chromosome numbers for eight members of the family Aspleniaceæ (*sensu* Ching, 1940) from Kulu Valley and one from Mussoorie, have been recorded. Out of these, for five species there is no previous data. All are cytologically normal and hybridity or apogamy is totally absent. Taxonomic confusion about *Asplenium dalhousie* and *Diplazium poly-podioides* has been cleared. A comparison with European and Ceylonese data on Pteridophytes has been made. *Athyrium proliferum* Moore is a new record for Western Himalayas. *Athyrium spectabile* should better be called a *Diplazium*.

ACKNOWLEDGEMENTS

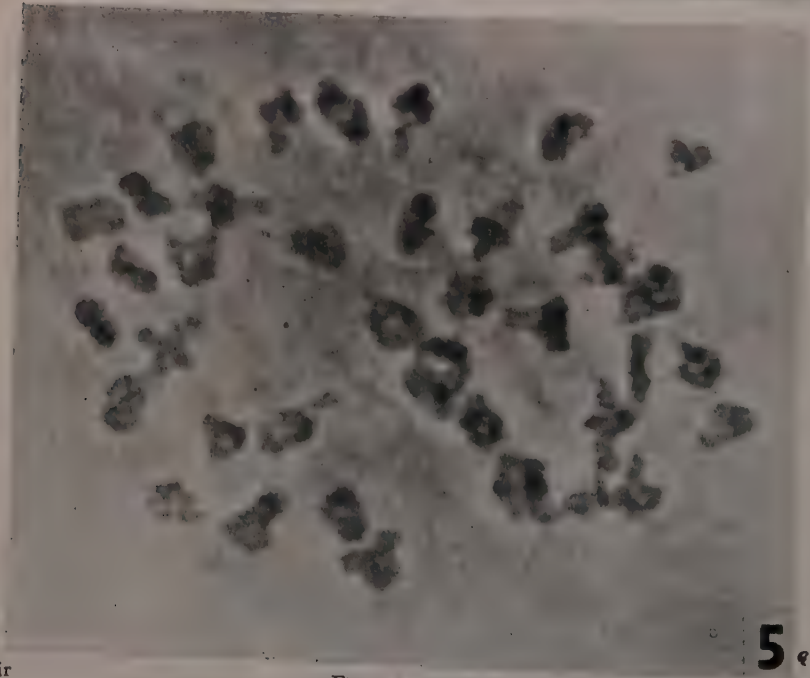
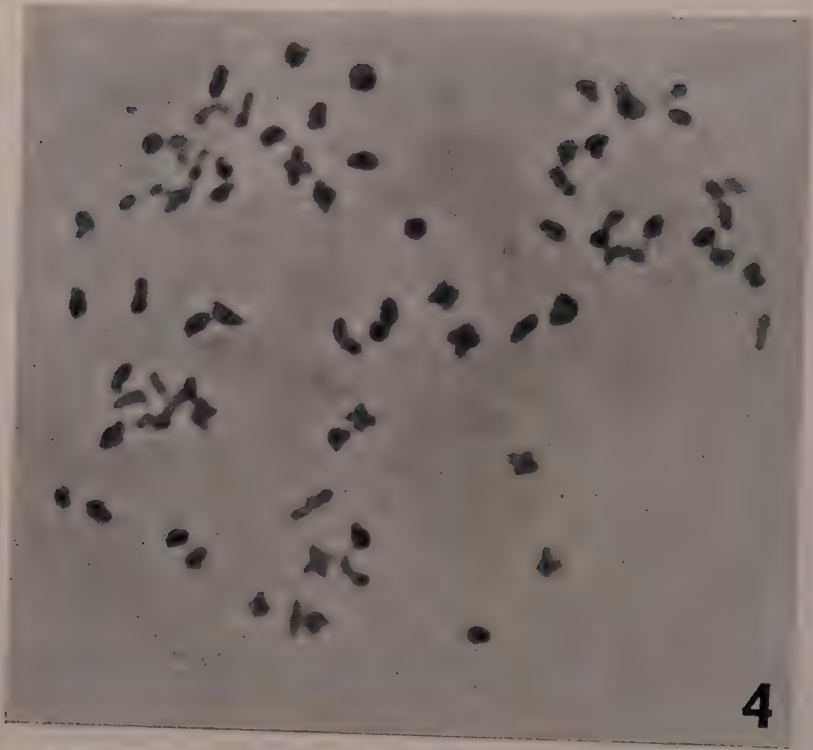
The writer expresses his extreme sense of gratitude to Prof. P. N. Mehra for his kind guidance and encouragement and for providing facilities to visit Kulu Valley. His thanks are also due to the late Mr. A. H. G. Alston of British Museum for identification, to Prof. R. C. Ching of Academia Sinica, Peking, for providing relative information, to Mr. R. S. Pathania for microphotographs, to Mr. B. Khanna for help with drawings and finally to the Government of India for the award of a Senior Research Scholarship during the course of investigations.

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FIGS. 1-3



S. S. Bir

FIGS. 4 AND 5

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- * Not seen in original.

EXPLANATION OF PLATES

PLATE XII

- FIG. 1. Plants of *Asplenium dalhousie* growing in the crevices of masonry works at Kulu.
- FIG. 2. A spore mother cell of *A. dalhousie* showing 36 bivalents, $\times 2,500$.
- FIG. 3. *Athyrium proliferum* with $n = 40$ at meiosis in a spore mother cell, $\times 2,500$.

PLATE XIII

- FIG. 4. A spore mother cell of *Ceterach officinarum* with 72 bivalents, $\times 2,500$.
- FIG. 5. *Diplazium polypodioides*, Spore mother cell with $n = 41$, $\times 2,500$.

THE GENUS *RICCARDIA* GRAY IN INDIA

II.* *Riccardia palmatiformis* Schffn. and *R. decolyana* Schffn.

BY V. SCHIFFNER,† S. K. PANDÉ AND K. P. SRIVASTAVA §

Department of Botany, University of Sagar, Sagar

(Received for publication on March 4, 1959)

INTRODUCTION

IN the first paper of this series Pandé and Srivastava (1958) gave a taxonomic account of *Riccardia levieri* Schffn. The present paper deals with *R. palmatiformis* Schffn. and *R. decolyana* Schffn. A preliminary note on these species was communicated to the Indian Science Congress (Schiffner, Pandé and Srivastava, 1958).

The species under consideration were instituted by one of the authors (Schiffner) on the basis of specimens collected by Rev. P. Decoly and Schaul in 1899, from Kurseong, 6,000 ft. Eastern Himalayas, and the account given here is based on his manuscript notes, supplemented from a study of the specimens. Both the species differ from all the known species of the genus which have so far been published (Schiffner, 1899; Stephani, 1898-1900, 1917-24; Horikawa, 1933, 1934; Hattori, 1951; Arnell, 1952, 1954).

DESCRIPTION

Riccardia palmatiformis Schffn.

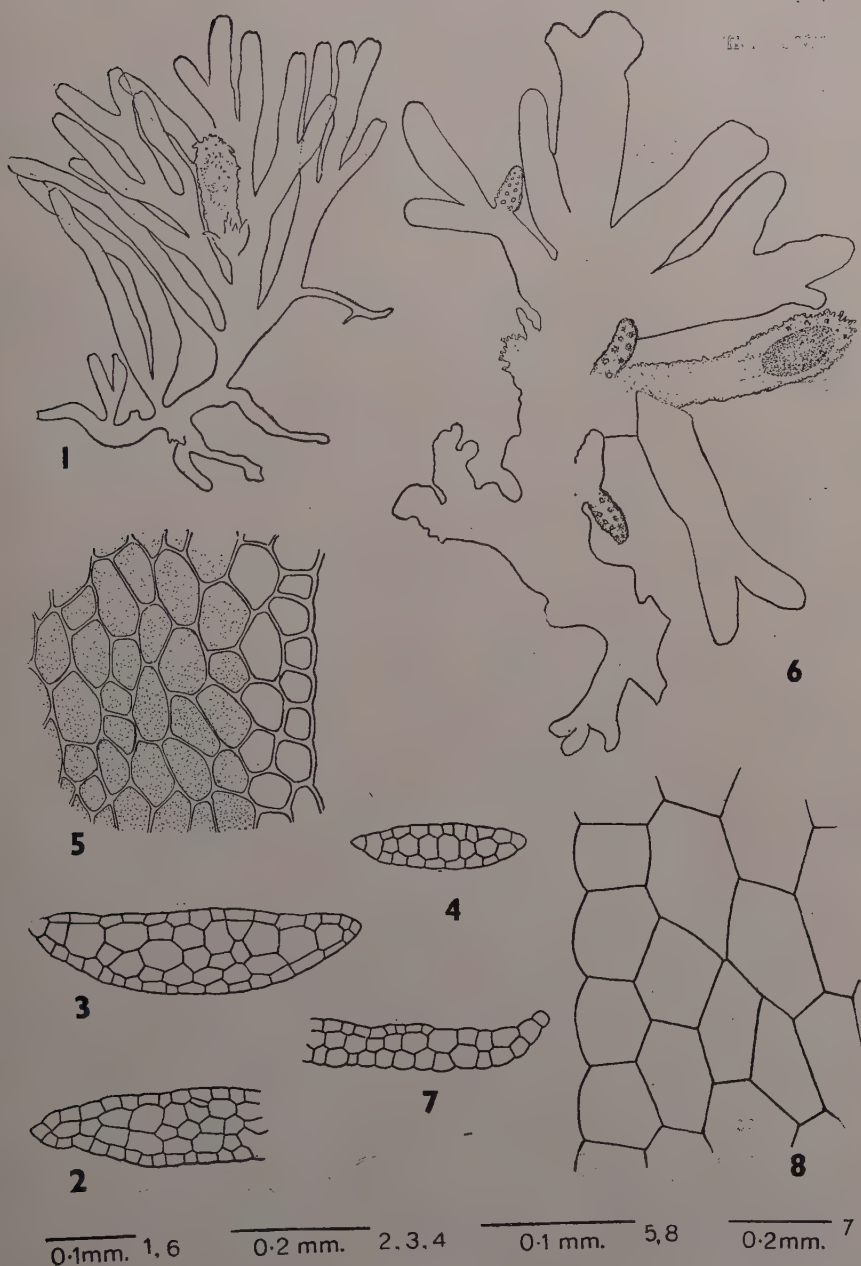
Herba dioica, minuta, plus minusve olivaceo-viridis, dense cæspitosa, usque ad 10 mm. longa, iterum iterumque ramosa. Thallus biconvexus vel plano-convexus, usque 5 cellulis crassus ad medium. Cellulæ marginales minores cellulis mediis. Pinnularum apices biconvexi, ca. 3 cellulis crassi, cellulis centralibus magnis. Cellulæ superficiales polygonales, tetragonæ ad hexagonas, magnitudine variabili. Cellulæ marginales minores, tetra- vel pentagonæ. Inflorescentia feminea solitaria, brevis, cupuliformis, marginibus laciniatis. Calyptræ 4 mm. longa, aspera et verrucosa. Cætera non visa.

Riccardia palmatiformis Schffn. grows on rocks associated with other liverworts and mosses, forming small dense cushions. The

* Contribution from the National Botanic Gardens, Lucknow.

† The late Prof. Schiffner was at Vienna.

§ Present Address: Botany Laboratory, National Botanic Gardens, Lucknow, India.



TEXT-FIGS. 1-8. Figs. 1-5. *Riccardia palmatiformis* Schffn. Fig. 1. Female plant. Fig. 2. T.S. Pinna. Fig. 3. T.S. pinnule. Fig. 4. T.S. pinnule near the tip. Fig. 5. Surface cells. Figs. 6-8. *Riccardia decolyana* Schffn. Fig. 6. A plant. Fig. 7. T.S. pinnule. Fig. 8. Surface cells.

specimens include only sterile and female plants bearing archegonia and sporophytes, the latter still enclosed within the calyptra. Presumably the species is dioecious and the male plants have escaped collection. The thallus is up to 10 mm. long, repeatedly branched, the branches spreading out in a fan-shaped manner. Tuberous cylindrical shoots (stolons), which serve as organs for vegetative propagation, are developed on the ventral side of the main thallus. At the tip of the ultimate branches gemmæ are produced profusely.

The cross-section of the main shoot and the larger branches is biconvex or more or less plano-convex, and is up to 5 cells thick in the middle. The margin of the ultimate lobes (pinnules) is 1-2 cells thick and the cells are much smaller. The walls of the marginal cells are somewhat thickened. Towards the extreme tip the pinnules are biconvex in cross-section, and only about 3 cells thick. The central cells are somewhat larger than the outer ones. The cells are otherwise similar. The surface cells are polygonal, generally 4-6-sided and variable in size. The marginal cells are comparatively smaller and generally 4-5-sided.

The calyptra is about 4 mm. long and is very rough due to the growth of warts all over its surface, especially at the crown.

R. palmatiformis is very similar to *R. palmata* but is distinguished from it because of its larger size, thinner thalli and larger calyptra.

Habitat.—Sepoydura Government Forest, Kurseong, 6,000 ft., Eastern Himalayas. On moist rocks.

Collector.—Rev. P. Decoly and Schaul, 1899 (Nos. 205, 543, 545 and 632).

Riccardia decolyana Schffn.

Herba monoica, tenuis, pallide viridis, dense cæspitosa, usque ad 2.5 cm. longa, marginibus crenulatis. Thalli tenues, cellulis magnis et tenui pariete præditis, cellulis superioribus quam cæteris minoribus; cellulæ superficiales pentagonæ, $50-90\mu \times 30-42\mu$. Cellulæ marginales penta- vel hexagonæ, ca. $40 \times 35\mu$. Alæ cellulis 1 vel 2 latæ. Surculi feminei laterales. Calyptra 5 mm. longa, superficie aspera. Surculi masculini parvi, vulgo juxta surculum femineum, marginibus incurvis, antheridiorum 3-7 paribus.

Riccardia decolyana Schffn. grows on ground and tree trunks forming large patches and is associated with mosses and other liverworts. The specimens are mostly sterile but a few fertile plants bearing sex organs and young sporophytes are also present. The plant is monoecious, thin, pale green, repeatedly branched and up to 2.5 cm. long, the margin more or less crenulate. The thallus is very thin and in cross-section the cells are large and thin-walled, the upper cells being comparatively smaller than the rest. The surface cells are pentagonal, $50-90 \times 30-42\mu$. The marginal cells are pentagonal or hexagonal, about $40 \times 34\mu$. The wing is 1-2 cells broad. The calyptra is up to 5 mm.

long and its surface is rough. The male shoot is small, often lies by the side of the female shoot and frequently shows curved margins. It bears 3-7 pairs of antheridia.

While examining specimens of *Riccardia decolyana* the authors came across a few plants in which some of the scales on the calyptra had become greatly enlarged and thalloid. Such structures when detached may grow into independent plants and presumably serve for vegetative propagation.

Habitat.—Sepoydura Government Forest and Chuttakpur Government Forest, Kurseong, 6,000 ft., Eastern Himalayas. On moist rocks and tree trunks.

Collector.—Rev. P. Decoly and Schaul, 1899 (Nos. 204, 206, 304, 633 and 634).

SUMMARY

Two new species of *Riccardia*, viz., *Riccardia palmatifomis* Schffn. and *R. decolyana* Schffn. are described. The species occur at Kurseong, 6,000 ft., in the region of the Sikkim Himalayas.

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EXPLANATION OF PLATE XIV

FIGS. 1-2. *Riccardia palmatiformis* Schffn.

FIG. 1. Female plant.

FIG. 2. Plant showing gemmæ at the tip of the pinnules.

FIGS. 3-8. *Riccardia decolyana* Schffn.

FIGS. 3-4. Plants.

FIG. 5. Plant with male shoots and sporophyte (σ^7), male shoot; (*sp.*), sporophyte.

FIG. 6. Plant (dorsal view). A scale on calyptra has become thalloid and enlarged.

FIGS. 7-8. A part of Fig. 6 (ventral view) more highly magnified.



A NEW SPECIES OF *CHAETOMIUM* FROM HYDERABAD-DN.

BY M. A. SALAM AND (MISS) M. NUSRATH

Botany Department, Osmania University, Hyderabad-Dn.

(Received for publication on 21-3-1959)

DURING the course of investigations on Coprophilous fungi in this laboratory, a species of *Chaetomium* was isolated from cow-dung, and its cultural and morphological characters were studied in potato-dextrose-agar and Czapek's medium. As the fungus under study does not agree with any of the species described by Chivers (1915), Greathouse and Ames (1945), Skolko and Groves (1948, 1953), Ames (1949, 1950), La Touche (1950) and Omvik (1951), it is reported here as a new species.

Chaetomium hyderabadense Salam and Nusrath sp. nov.

Perithecia large, brown, becoming darker with age, clothed in gray hairs, subglobose to ovoid, slightly beaked when mature, $158.4-259.4 \times 111.6-198.0 \mu$ ($205.6 \times 150.8 \mu$), attached to the substratum by rhizoids. Ostiole very narrow, surrounded by terminal hairs. Terminal hairs spirally coiled only in the upper half with three to four coils, unbranched, $3.2-4.8 \mu$ wide, up to 8-septate, finely roughened or smooth with rounded tips. Lateral hairs straight, septate, light coloured with slightly bulbous basal cells. Asci 8-spored ovate to clavate, hyaline, thin-walled without paraphyses.

Ascospores light brown, 1-celled, broadly ovoid, biseriately arranged in the ascus, smooth, measuring $8.0-8.8 \times 4.8-7.2 \mu$ ($8.3 \times 5.7 \mu$).

Habitat.—Isolated from cow's dung, University Campus, Hyderabad-Dn., 17-4-1958. Type culture deposited at the Commonwealth Mycological Institute, Kew, Surrey, No. 75168.

Chaetomium hyderabadense Salam and Nusrath sp. nov.

Perithecia ampla, brunneæ, evadentes fusciores ad maturitatem capillis griseis vestitæ, subglobosa vel ovoidea, tenuiter rostrata ad maturitatem, $158.4-259.4 \times 111.6-198.0 \mu$ ($205.6 \times 150.8 \mu$), substrato fixa rhizoideis. Ostiole angustissima, circumdata capillis terminalibus; hi vero capilli ter quatterve curvantur spiraliter in dimidia parte superiore, simplices, $3.2-4.8 \mu$ lati, septati, minute asperati vel leves, apicibus rotundatis. Capilli laterales recti, septati, pallide colorati cellulis basalibus tenuiter bulbosis. Asci octospori, hyalini, ovati vel clavati, tenuibus parietibus præditi, paraphysibus nullis. Ascosporæ pallide brunneæ, unicellulatæ, late ovoideæ, biseriatim dispositæ in asco, leves, magnitud. $8.0-8.8 \times 4.8-7.2 \mu$ ($8.3 \times 5.7 \mu$).



TEXT-FIG. 1. *Chaetomium hyderabadense* Salam, M. A. and Nusrath, M. sp. nov.
 A. Perithecium—with spirally coiled setæ.
 B. Seta— $\times 1,000$.
 C. Asci—with distichous ascospores.

Habitat.—Typus lectus in fimo vaccino, campus universitatis, Hyderabad-Dn. die 17 Aprilis anni 1958. Positis in Cult. Commonwealth Mycological Institute, Kew, Surrey, sub-numero 75168.

The fungus under study is close to *Chaetomium brasiliense* Batista and Pontual but differs in having larger perithecia, setæ which are spirally coiled only in the upper half and distichous ascospores.

ACKNOWLEDGEMENT

We are grateful to Prof. M. Sayeeduddin for encouragement during the investigation. Our thanks are also due to Prof. H. Santapau for the Latin translation and to Dr. Booth of the Commonwealth Mycological Institute, Kew, Surrey, for confirmation of the species.

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A NEW SPECIES OF *HAPLOSPORELLA* FROM ASSAM

BY V. AGNIHOTHRUDU AND WILLIAM HADFIELD*

(Tocklai Experimental Station, Indian Tea Association, Cinnamara, Assam)

Received for publication on December 5, 1958

IN the month of September 1957 an interesting member of the phæo-
sporous sphærospidales was observed on dead snags and bark of a
solitary *Aleurites montana* Wilson growing in the campus of Tocklai
Experimental Station. The fungus, which is possibly responsible for
the die-back was then identified as a *Sphærospis* but further reference
to literature revealed it to be a species of the genus *Haplosporella sensu*
Petrak et Sydow (1926).

Until now seven species of *Haplosporella* have been described from
India. They are *Haplosporella capparidis* (Diedicke) Petrak and Sydow
on *Capparis* sp.; *H. dalbergiae* (Died.) Pet. and Syd. on *Dalbergia sisso*
Roxb.; *H. gossypii* (Died.) Pet. and Syd. on *Gossypium* sp.; *H. mangi-
ferae* (Died.) Pet. and Syd. on *Mangifera indica* L. (Butler and Bisby,
1931); *H. dracenarum* (Penzig and Saccardo) Petr. on *Dracæna* sp.
and *H. phyllanthina* Syd. on *Phyllanthus reticulatus* Poir. (Mundkur,
1938). Recently Srivastava (1956) described *Haplosporella dryobalanop-
sidis* on fruits of *Dryobalanops aromatica* Gaertn. imported from Malaya.

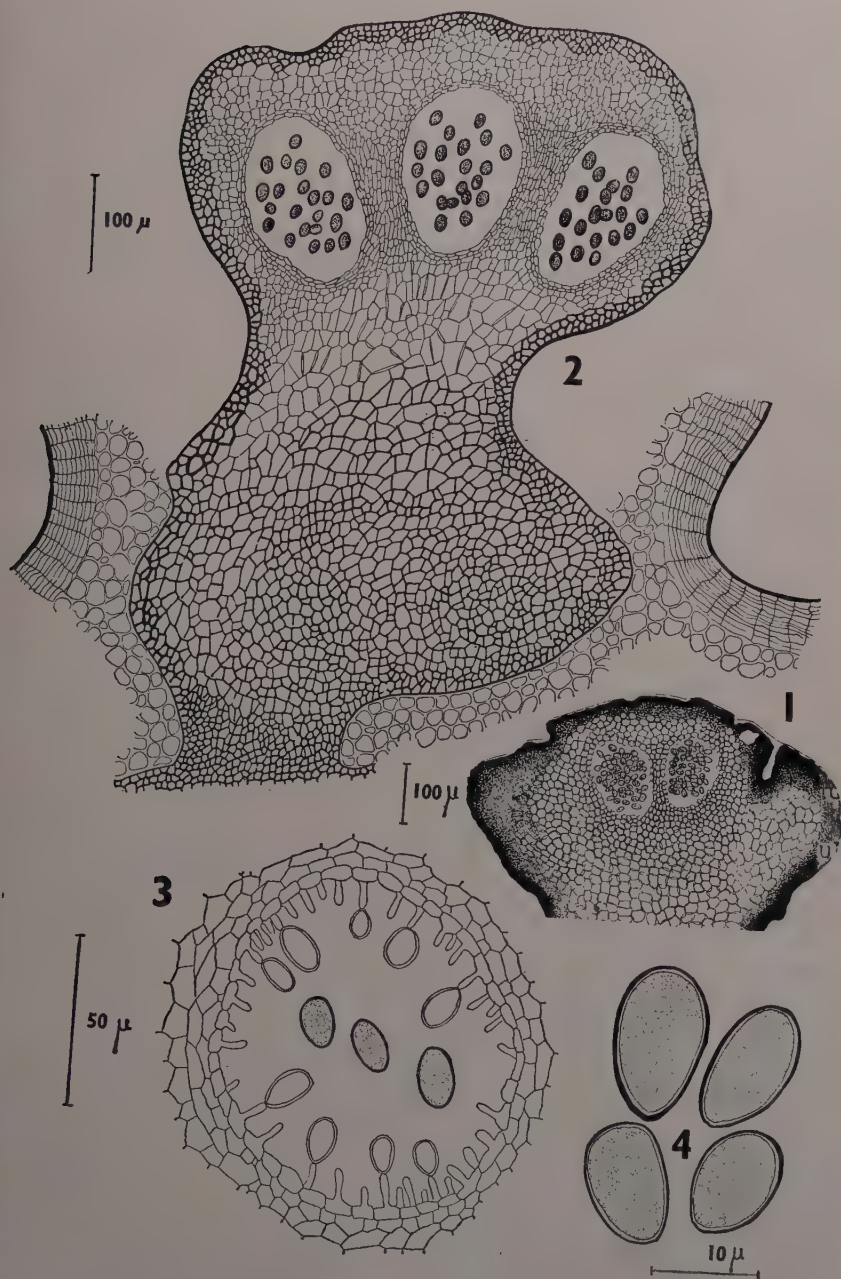
Since speciation in sphærospidales is largely based on host, the
fungus occurring at Tocklai is described as a new species, namely *Haplo-
sporella aleuritidis* (Text-Figs. 1-4). The following description is based
on a recent collection.

Haplosporella aleuritidis Agnihothrudu et Hadfield Sp. Nov.

Stromata separata, raro gregaria, primo immersa, tum erumpentia,
circumdata cortice fisso, fusca, carbonacea, globosa vel irregularia vel
pulvinata, magnitudinis 600-800 μ diam. atque usque 1 mm. alta, stromate
basali fortiter evoluto. Pycnidia 3-5, immersa in catervis botryosis,
diametientia 150-225 \times 70-150 μ , obtuse papillata. Conidia subhyalina,
continua crassis parietibus prædita, tum ad maturitatem evadentia
fusca, subelliptica vel obovata, sæpe hilo ornata, magnit. 16-20 \times 10-12 μ
vulgo 20 \times 12 μ , contentis regularibus vel granularibus. Conidiophori
breves, continui, hyalini, sæpe obscuri.

Typus lectus in cortice emortuo *Aleuritis montanæ* Wilson in
campo Stationis Experimentalis Tocklai a V. Agnihothrudu die 5 sep-
tembris anni 1958 et positus in Herbario Mycologico ad Tocklai Experi-
mental Station.

* Senior Assistant Mycologist and Advisory Officer respectively.



TEXT-FIGS. 1-4. *Haplosporella aleuritidis* Agribothrudu and Hadfield. Figs. 1-2. Vertical sections through stroma showing the pycnidia. Fig. 3. Section through a pycnidium showing the conidia and conidiophores. Fig. 4. Conidia.

Haplosporella aleuritidis Agnihothrudu and Hadfield Sp. Nov.

Stromata separate, very rarely gregarious, immersed first, later becoming erumpent, embraced by the ruptured bark, dark, carbonous, globose to pulvinate or irregular measuring $600-800\mu$ in diameter and up to 1 mm. in height with a strongly developed basal stroma which is almost two-thirds the total height. Pycnidia 3-5, immersed in botryose groups, individually measuring $150-225\mu$ by $70-150\mu$ in diameter, obtusely papillate. Conidia subhyaline, continuous, thick-walled, later becoming fuscous with maturity, subelliptic to obovate, often with a hilum, measuring $16-20\mu$ by $10-12\mu$, mostly 20 by 12μ with uniform or granular contents. Conidiophores short, continuous, hyaline, often obscure. Pseudophysoids absent.

Type collected on dead bark of *Aleurites montana* Wilson growing in the campus of Tocklai Experimental Station by V. Agnihothrudu on 5th September 1958, deposited in the Mycological Herbarium, Tocklai Experimental Station and Herbarium Cryptogamiae Indiae Orientalis, New Delhi.

ACKNOWLEDGEMENTS

We are grateful to the Director, Tocklai Experimental Station, for permission to publish this short paper and to Professor Dr. Rev. Fr. H. Santapau for rendering the Latin diagnosis and for his helpful suggestions in naming the fungus.

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TWO YEARS' OBSERVATION ON THE PERIODICITY OF EUGLENINEAE IN TWO FISH-BREEDING PONDS

BY A. R. ZAFAR

National Research Fellow, Department of Botany, Osmania University, Hyderabad-7

(Received for publication on September 20, 1958)

THE present contribution is based on the data collected during 3-8-1952 to 16-6-1954 regarding the periodicity of Euglenineae in two fish-breeding ponds near the City of Hyderabad, Andhra Pradesh, India. The ponds lie quite near to each other, apparently on the same geological formation, and will be referred to hereafter as ponds A and B.

Pond A is smaller being 60' \times 45' and 3' deep whereas pond B is 125' \times 65' and is 4' in depth.

Samples of surface water were collected from each pond at the interval of one month for chemical analysis. The factors recorded were, water temperature, pH, CO₃, HCO₃, Cl, NO₃, NO₂, PO₄, Si, Fe, free NH₃, albuminoid NH₃, dissolved O₂, CO₂, oxidizable organic matter, Ca, Mg, Na, K and total solids. Standard methods, recommended by the American Public Health Association (1947), were followed in the analysis of water samples.

Algæ were collected at the interval of 15 days, viz., along with the water samples and once in between the two subsequent collections, more or less in the same way as suggested by Rao (1953). For frequency estimations drops from the collection bottles were mounted on 12 slides and from each drop 12 high-power microscope fields (10 \times 40) were examined and individuals counted. Thus the frequency of a species in a particular sample was taken as the total number of its individuals appearing in 144 fields of the microscope.

Table I gives a broad outline of the average concentrations of the various factors observed in these ponds. Pond A resembles eutrophic lakes (Strom, 1930) since it is rich in calcium, nitrate and phosphate. Pond B, on the other hand, occupies a peculiar position in this respect. During the first year of investigation it had quite low percentages of calcium, nitrate and phosphate, and resembled the oligotrophic lakes (Strom, *loc. cit.*). But during the second year of observation, the averages of calcium and nitrate increased considerably, thus bringing it closer to the eutrophic waters. However, on the basis of the two-year averages of these factors, this pond may also be grouped with eutrophic waters having comparatively low calcium and phosphate contents.

TABLE I

	Pond A		Pond B		Averages for both the years	
	Averages for 1952-53	Averages for 1953-54	Averages for 1952-53	Averages for 1953-54	Pond A	Pond B
pH	8.1	7.5	8.9	7.9	7.8	8.4
Carbonate m.e.l.	0.5351	0.094	1.685	0.398	0.3146	1.0415
Bicarbonate „	5.098	4.997	3.666	5.214	5.0485	4.440
Chloride „	2.025	1.919	3.719	3.522	1.972	3.6205
Phosphate „	0.006	0.0028	0.0035	0.002	0.0044	0.0028
Silica mg./l.	6.27	2.9	5.4	3.9	4.585	4.650
Iron „	0.7	0.5	0.69	0.36	0.6	0.525
Nitrate m.e.l.	0.0016	0.006	0.0007	0.0059	0.0038	0.0033
Nitrite mg./l.	0.0067	0.2600	0.0073	0.250	0.1334	0.1287
Free-NH ₃ „	0.241	0.156	0.063	0.08	0.1985	0.0765
Alb.-NH ₃ „	0.298	0.333	0.463	0.36	0.3155	0.5115
Dissolved O ₂ „	3.890	8.431	6.85	9.38	6.1605	8.115
Free-CO ₂ „	0.054	0.27	Nil	0.15	0.162	0.075
Calcium m.e.l.	1.612	2.188	0.925	1.663	1.90	1.294
Magnesium „	1.334	1.724	1.466	2.123	1.529	1.7945
Sodium „	2.424	3.316	5.057	4.550	2.870	4.8035
Potassium „	0.368	0.681	0.439	0.686	0.5245	0.5625
Total Solids mg./l.	763.8	837.2	756.5	883.1	800.5	819.8
Oxidizable Organic matter mg./l.	1.8	1.8	2.6	1.7	1.8	2.15

Since many workers including Fritsch and Rich (1909, 1913), Delf (1915), Lind (1938), Gonzalves and Joshi (1946) and Rao (1955) attach much importance to the temperature, dissolved organic matter, albuminoid NH₃ and C/N ratio in connection with the periodicity of

Euglenineae, it seems quite relevant to discuss here, in some detail, the periodical changes of these factors and their interrelationships with certain other ecological factors operating in pond waters under discussion.

According to James (1941), organic matter exists in water in colloidal as well as soluble form. From the chemical point of view one may divide it in two fundamental components:

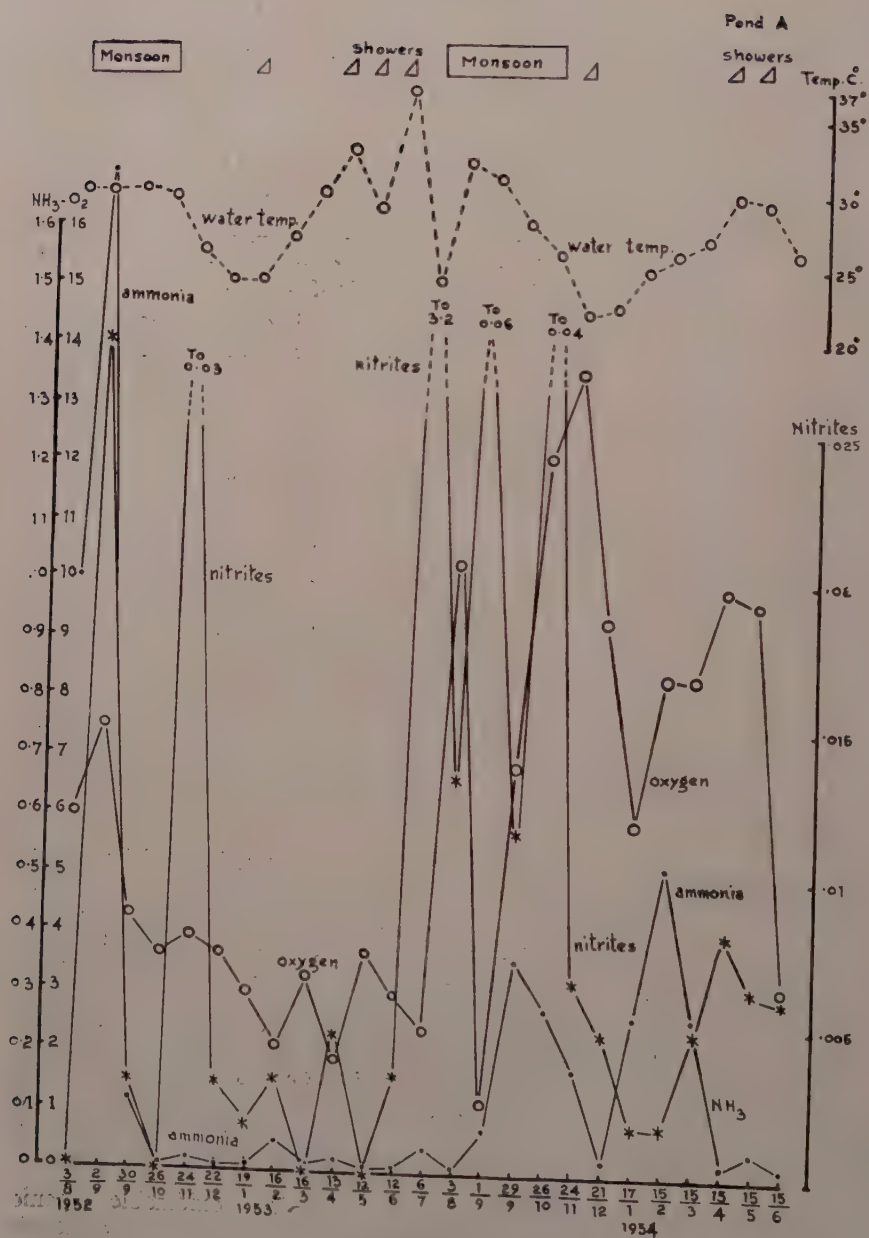
- (i) *Oxidizable Organic Matter*.—When decomposed, gives rise to carbon dioxide and is usually estimated in laboratory as "Oxygen consumed from permanganate".
- (ii) *Nitrogenous Organic Matter*.—When this decomposes peptones, polypeptides and proteoses are formed which finally break down to nitrites and ammonia along with other minor products. This is estimated in the form of albuminoid ammonia in laboratory.

Both of these are rather physically inseparable components of the "total organic matter."

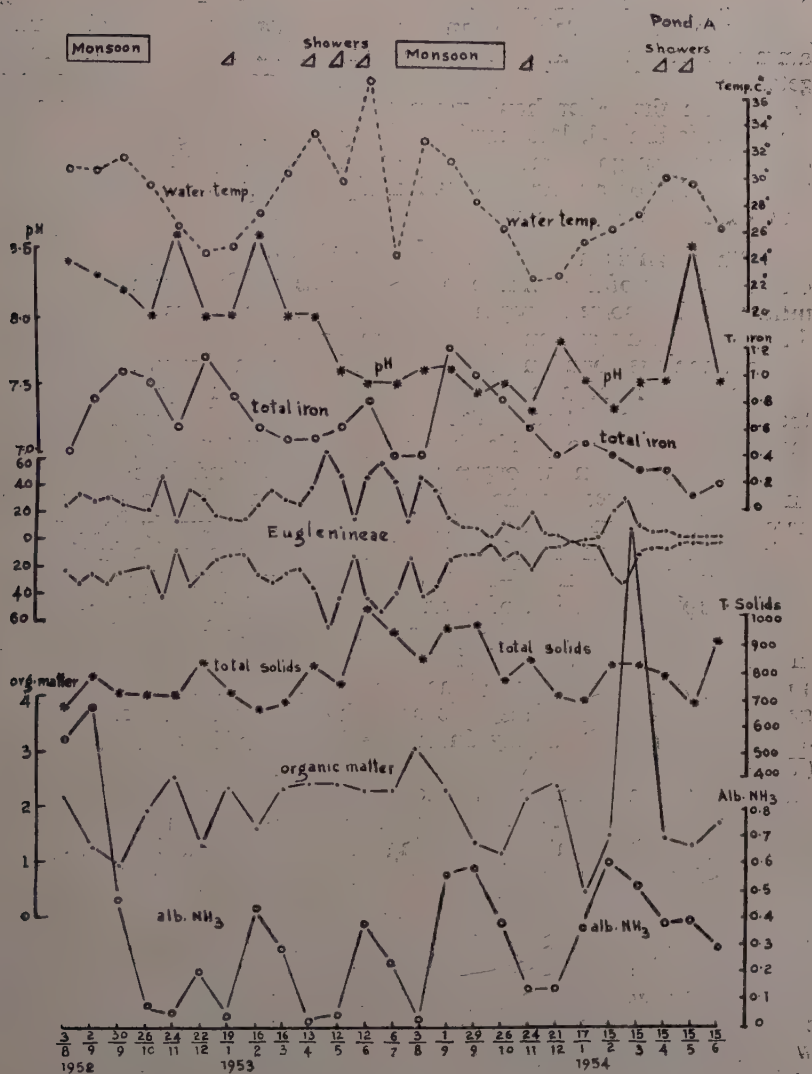
In the present data oxidizable organic matter ranges from undetectable concentrations (January, 1954) to 6.8 mg./l. (March, 1954) in pond A and from very low concentrations (January, 1954) to 4.5 mg./l. (August, 1953) in pond B. Its monthly fluctuations in both the ponds do not show any definite relationship with water temperature although this much is certain that it falls down to very low concentrations in winter. It may rise during heavy rains as happens in pond B (August, 1953) or in summer as is noted in pond A (March, 1954). The present data indicate that pH usually increases with the increase of oxidizable organic matter in water while the concentration of total iron goes down (Text-Figs. 2 and 4).

A probable interpretation of these findings can be as follows. In waters where the oxidizable organic matter undergoes active decomposition with the resultant decrease in its concentration, the carbon dioxide evolved gets dissolved in pond water and lowers its pH. On the contrary when the process of accumulation of oxidizable organic matter in water is much faster than its decomposition, the waters remain alkaline. Uspenski (1927) has shown that solubility of iron salts in water depends much on its pH. Thus when the water is more alkaline only small quantities of iron can be supported by it. On the other hand when the pH of water is comparatively low, larger quantities of iron go into solution. This may account for the observed relationships among oxidizable organic matter, pH and iron contents of pond waters.

It is rather striking that in the present data oxidizable organic matter appears to vary inversely with the albuminoid ammonia, although Drew (1914) reports a direct relationship between the two and Gonzalves and Joshi (1946) and Rao (1949) correlate them in their summer data. Their inverse relationship is more pronounced in pond A than in B



TEXT-FIG. 1



TEXT-FIG. 2

(Figs. 2 and 4). It may be emphasized here that albuminoid ammonia is a measure for readily available nitrogenous organic matter in water, the concentration of which, as pointed out by Zobell (1940), influences the rate of bacterial activity. Taylor (1949) also concludes that the supply of readily available organic matter is the factor which controls primarily the activity of bacteria in lake waters. Thus, it is quite logical to assume that with the concentration of nitrogenous organic matter

bacterial activity also increases resulting in the simultaneous decomposition of the oxidizable organic matter. Therefore, when albuminoid ammonia increases, the rate of decomposition of the organic matter gets accelerated to such an extent that its concentration falls in pond water. On the other hand when the availability of the albuminoid ammonia is limited, less number of bacteria are active and oxidizable organic matter goes on accumulating in water. This accounts, to a large extent, for an inverse relationship between albuminoid ammonia and oxidizable organic matter.

Other significant chemical factors which appear to have a bearing on the ecology of Euglenineæ in these ponds are free-ammonia, nitrites, nitrates and dissolved oxygen. Free-ammonia increases in these ponds during the rainy season. Matsudaira and Kato (1943) have shown that ammonia is abundant in winds with high humidity and temperature. Such conditions of atmosphere are quite usual in Hyderabad during the rainy season. It may also be assumed that free-ammonia which may be brought into ponds through the rain water or by the decomposition of nitrogenous organic matter, is oxidized into nitrites and finally into nitrates by the activity of bacteria. In the present data here are indications that rise in free-ammonia is usually followed by a rise in nitrite content of water. The extraordinary rise in the concentration of nitrite on 6-7-1953 (Text-Figs. 1 and 2) may be attributed to the incomplete oxidation of ammonia. It is rather difficult to suggest, on the basis of the available data, any particular reason for such an incomplete oxidation, but it is quite probable that deficiency of dissolved oxygen in pond water may be responsible for it. This outlook gathers more weight when it is seen that larger quantities of nitrites accumulate in water usually during the periods of low oxygen contents (Text-Figs. 1 and 2). A comparison of the yearly averages of dissolved oxygen, free-ammonia and nitrate (Table 1) also gives the same picture. It is evident that in 1953-54 when the dissolved oxygen increased, nitrates also increased substantially, showing that more quantities of ammonia were oxidized to nitrates.

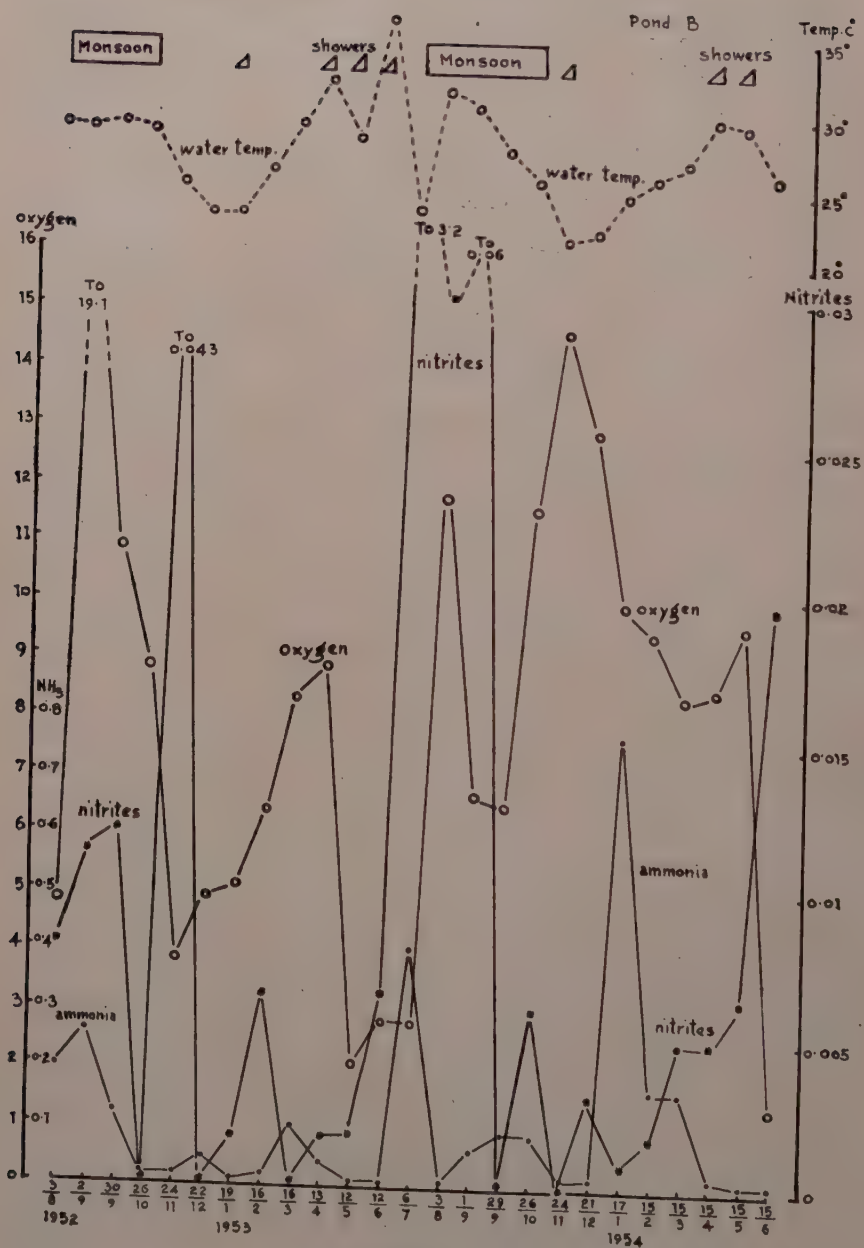
In the ponds the Euglenineæ are represented in the main by species of *Euglena*, *Lepocinclis*, *Phacus* and *Trachaelomonas*. Although their percentage is quite low as compared to the other groups of algæ present, they evidently show a better growth in pond A. In this, they start increasing in number soon after the summer showers and persist well during the early weeks of rainy season. Their percentage in pond water decreases evidently as the heavy rains follow. A few species, particularly those of *Trachaelomonas* multiply again at the end of rainy season, when winter is just approaching, but this pulse is rather short lived. At the end of summer season when the rains are just to start species of *Euglena* and *Phacus* become abundant. In pond B also, similar pulses of Euglenineæ are noted but, during the first year of observation, they persisted in good number even during the rainy season. It is interesting to note in these data that pulses of euglenoid flagellates, observed during the different months of the year, are brought about by different species. This naturally tends to suggest that different

species of Euglenineae react diversely to the varied conditions of water temperature. The species of *Trachaelomonas*, particularly *T. volvocina* Ehr., *T. volvocina* Ehr. var. *derephora* and *T. perforata* Awerinzew amend. Dafflandre, react favourably to comparatively low water temperatures (26–29° C.). On the other hand the species of *Euglena*, *Phacus* and *Lepocinclis* appear to prefer higher water temperatures (30–37° C.) for their active multiplication. However, the interrupted peaks of Euglenineae in general do indicate that their periodicity involves some factors other than the temperature. Total solid content of water which is assumed to be one of the important factors in the periodicity of these flagellates by Hodgetts (1922), does not appear to play a very important role in these ponds. On several occasions (Text-Fig. 4) even marked changes in the concentration of pond water do not bring appreciable change in the intensity of euglenoid population. Furthermore, in pond A the total solids remained almost at the same level of concentration during September to November, 1952 (Text-Fig. 2) while various fluctuations occurred in the frequency of Euglenineae. This naturally tends to suggest that the concentration of water does not play a very significant role in the periodicity of euglenoid flagellates present in these ponds. Howland (1931) also records similar findings.

In pond A, there are indications that Euglenineae and oxidizable organic matter go almost hand in hand, but sudden and steep falls in their number on so many occasions (November 1952, May to August 1953, Text-Fig. 2) do suggest that some other factors were inhibiting their growth. A comparison of Text-Figs. 1 and 2, shows that whenever the percentages of free-ammonia or nitrites increase in pond water, Euglenineae go down in number. This may suggest that higher concentrations of free-ammonia and nitrites are toxic to euglenoid flagellates. Gonzalves and Joshi (1946) have noted a gradual rise in free-ammonia during rains along with a gradual fall in the number of flagellates. Rao's (1949) data also seems to support this view. The yearly averages for the free-ammonia contents of the five ponds of his study (excluding the Lemna Pond) vary between 0.064 and 0.104 mg./l. The Lemna Pond which, according to Rao (*loc. cit.*), had comparatively very few Euglenineae, closely resembles the pond A in its free-ammonia content (both showing 0.199 mg./l. free-NH₃). This obviously suggests that the average concentrations of free-ammonia more than 0.104 mg./l. in pond waters may have toxic effects on the growth of euglenoid flagellates.

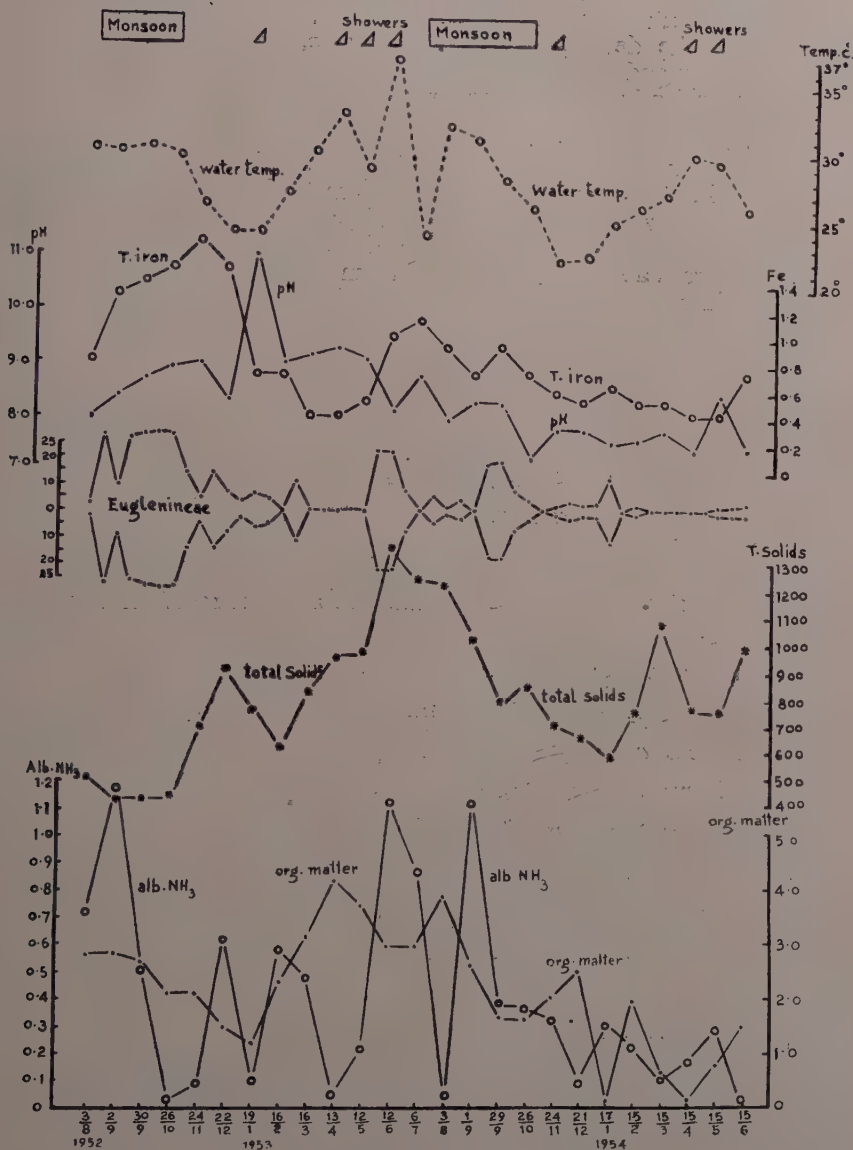
It has already been discussed above that the deficiency of dissolved oxygen in water leads to the accumulation of nitrites and free-ammonia. Thus, one may assume that dissolved oxygen indirectly influences the periodicity of these flagellates.

It may again be emphasized that the nitrogenous organic matter and oxidizable organic matter show an inverse relationship in the present data. Since the periodicity of Euglenineae appears to be influenced by the oxidizable organic matter in pond A, one may also surmise that the maxima of Euglenineae may occur in waters poor in nitrogenous



TEXT-FIG. 3

Pond B



TEXT-FIG. 4

organic matter. In other words organic sources of carbon rather than of nitrogen are more important for the growth of euglenoid population. Rao (1953) points out that waters exhibiting higher C/N ratio are more suitable for the development of *Eugleninæ*, but as the oxidizable organic matter and albuminoid ammonia did not vary inversely in his ponds, he evidently did not pay much attention to this aspect.

In pond B, the fluctuations in the total iron content of water do show some similarity with the variations of the euglenoid population (Text-Fig. 4). This pond, as is evident from Table I, is more alkaline and consequently supports lesser quantities of iron, as compared to those in pond A. It may be that iron deficiency along with the other factors discussed above, render this pond unsuitable for the development of *Eugleninæ*.

SPECIES OBSERVED

Euglena Ehr.

1. *Euglena limnophila* Lemm.
2. *Euglena tripteris* (Duj.) Klebs.
3. *Euglena spirogyra* Ehr.

Lepocinclis Perty

4. *Lepocinclis ovum* (Ehr.) Lemm. var. *punctate-striata* Lemm.

Phacus Duj.

5. *Phacus pusillus* Lemm.
6. *Phacus cylindrus* Pochmann
7. *Phacus aenigmaticus* Drez.
8. *Phacus curvicauda* Swirenko
9. *Phacus orbicularis* Hubner
10. *Phacus pleuronectus* (O.F.M.) Duj.
11. *Phacus circumflexus* Pochmann
12. *Phacus tortus* (Lemm.) Skvortzov

Trachaelomonas Ehr.

13. *Trachaelomonas volvocina* Ehr.
14. *Trachaelomonas volvocina* Ehr. var. *derephora* Conard
15. *Trachaelomonas perforata* Awerinzew amend. Deflandre
16. *Trachaelomonas armata* (Ehr.) Stein.

ACKNOWLEDGEMENT

The author is thankful to the Ministry of Scientific Research and Cultural Affairs, Government of India, for the award of a Fellowship

which enabled him to complete this work; to the authorities of the Department of Fisheries, Andhra Pradesh, for placing the two fish-breeding ponds at the disposal of the author for experimental purposes; to Prof. M. Sayeedud-Din, Head of the Department of Botany and Principal, University College of Science, Osmania University, for giving him the laboratory facilities and to Dr. M. R. Suxena, Reader and Supervisor, Hydrobiological Laboratory, Department of Botany, Osmania University, for his criticism and guidance.

SUMMARY

The paper is based on the data collected for a period of two years on the periodicity of Euglenineae in two fish-breeding ponds from the vicinity of Hyderabad. It takes into consideration, in some detail, the monthly variations and interrelationships of certain physico-chemical factors, viz., water temperature, pH, oxidizable and nitrogenous organic matter, iron, free-ammonia, nitrites, nitrates and dissolved oxygen, and their influence on the periodicity of euglenoid flagellates. It was noted that in one of the ponds oxidizable organic matter had an influence on the periodicity of Euglenineae, while in the other the total iron content of water was the influencing factor. Inhibiting effects of higher concentrations of free-ammonia and nitrites on the growth of euglenoid populations of these ponds have also been discussed.

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GENETIC STUDIES IN BARLEY

I. Inheritance of Pigmentation in Various Plant Parts

BY G. S. MURTY* AND K. B. L. JAIN

Division of Botany, Indian Agricultural Research Institute, New Delhi

(Received for publication on November 29, 1958)

INTRODUCTION

BARLEY, in India, is second in importance to wheat as a *rabi* or winter grain crop and occupies over 8 million acres. Uttar Pradesh, Rajasthan, Bihar and Punjab are the main barley growing States in that order and together account for more than 90% of the crop of this country. Improvement of barley was taken up in the third decade of this century at the Indian Agricultural Research Institute and in the States of Uttar Pradesh and Punjab. This work was mostly confined to selection from the indigenous material collected from various barley growing areas (Pal, 1957). Systematic breeding work for the improvement of yield, disease-resistance and other agronomical characters has been taken up recently at the Indian Agricultural Research Institute.

Barley has many easily determinable characters and only 7 pairs of chromosomes. For this reason it offers good material for inheritance studies. Considerable work on the genetics of this crop plant has been done in other countries and the mode of inheritance of more than a hundred characters has been studied. But in India, very little work has so far been done in this line. The present studies were taken up with the object of determining the mode of inheritance of various plant characters and to work out the relationships among them. This paper deals with the studies on the inheritance of pigmentation. The inheritance of other characters and their linkage relationships will be dealt with in subsequent publications.

Varieties of cultivated barley are characterized by the presence or absence of pigment in various parts like leaf-sheath, node, auricle, glume, pericarp, awns, etc. It may be mentioned that though considerable work on the genetics of various characters in barley has been done, much information is not available regarding the number of genes involved and their interrelationships in the expression of anthocyanin or melanin like pigment in different parts of the plant.

There are several types of chlorophyll deficiency in barley and they have been variously designated as albina, xantha, chlorina, virescence,

* Now Director, Tobacco Research, Central Tobacco Research Institute, Rajahmundry.

lutescens, etc., among the unicoloured deficiencies and spotted, striped, etc., among the variegated ones. Two varieties in the barley collection at this Institute are virescent and the results of the crosses between normal and these virescent types are also presented in this paper.

REVIEW OF LITERATURE

A fairly extensive review of literature on the inheritance and linkage relations in barley has been given by Robertson *et al.* (1941, 1947, 1955) and Smith (1951).

A complete treatment of the early literature on chlorophyll deficiencies, not only of the barley but of other crop plants has been given by H. De Haan (1933). Kiessling (1918) reported a chlorophyll defective mutant that behaved as a simple Mendelian recessive. Nilsson-Ehle (1922) described 6 different chlorophyll deficiencies in barley, 3 of which were albinos, 2 yellow and 1 chlorina type. Each behaved as a simple recessive when crossed with a normal green plant. Robertson (1929) and Robertson and Deming (1930) worked with different chlorophyll deficiencies and found each of them to be recessive to normal green and inherited on the basis of a single gene difference. Hallqvist (1927) reported the results of his investigations with chlorophyll deficient types—3 of which were classed as albinos, 2 as xanthas, 2 as virescents and 1 each as chlorina, super chlorina and lutescens. In crosses involving different albinos, a ratio of 9 green: 7 albinos was obtained and in a cross between virescent and xantha types, green, xantha and virescent seedlings occurred in a ratio of 9:3:4. Two cases of the effect of temperature on development of chlorophyll have been reported, one by Hallqvist (1923) and one by Collins (1927). Chlorophyll development was stimulated in chlorophyll deficient seedlings by an increase in temperature. These types of defectives proved to be simple Mendelian recessives.

Ubisch (1919) observed that red colour in the auricles, nodes and other places was dominant. Huber (1929) found the presence or absence of red pigment in the auricle to segregate in 3:1 and 10:6 ratios in different crosses. In a cross studied by Robertson (1933) purple straw was dominant over white and was mono-factorially determined. Briggs and Stanford (1943) found that red stem colour was determined by a single gene pair in a cross studied by them.

Harlan (1914) reported black colour in barley to be the result of a melanin-like pigment found in the lemma, palea and pericarp. Sigfusson (1929) pointed out that the black pigment does not express itself until just before ripening, making it difficult to classify the immature plants. Black 'flowering glume' colour is one of the characters that a large number of workers have studied and there is almost complete agreement as to its genetic basis. Black has been found to be completely dominant over white in the F_1 and a ratio of 3 black: 1 white has been observed in the F_2 (see Smith, 1951). Biffen (1907) and

Buckley (1930) noted that black *vs.* white pericarp behaved similarly and that black colour in the hulls was associated with colour in the grains which was localized in the pericarp. Ubisch (1919) was unable to decide whether black chaff and black pericarp were caused by the same gene or not. In crosses between black and white grained (and chaffed) types black colour was dominant and segregated in a 3:1 ratio. Savinskaja (1941) obtained purple seeded F_2 plants in crosses between black and white seeded plants. Of 78 F_2 plants, 62 had black, 10 had white and 6 had purple grains. Woodward (1941, 1942) concluded that different intensities of the black melanin-like pigment formation in both the pericarp and the flowering glume appeared to be controlled by a single series of allelomorphic genes. He distinguished 3 grades, *viz.*, black, grey and white and found that the darker colour was dominant over the lighter one, giving a ratio of 3:1 in F_2 .

MATERIAL AND METHODS

Five crosses, *viz.*, E*.B. 171 \times E.B. 417, E.B. 177 \times E.B. 417, K. 251 \times E.B. 438, K. 251 \times E.B. 132 and C 138-2 \times E.B. 132 were studied with reference to a number of different plant characters. The mode of inheritance of the following characters is reported in this paper.

1. Normal *vs.* virescent seedlings.
2. Purple *vs.* white leaf-sheath.
3. Purple *vs.* white node.
4. Purple *vs.* white auricle.
5. Black *vs.* white lemma and pericarp.
6. Black *vs.* white outer glume.
7. Black *vs.* white lemma awns (or hoods).

The study was made through F_1 , F_2 and F_3 generations in all the crosses. In addition, the back cross generation was also studied in some crosses. The parental varieties studied were differentiated by the following characters.

EXPERIMENTAL RESULTS

1. Inheritance of chlorophyll deficiency

The mode of inheritance of virescence of the seedlings was studied in F_1 , F_2 and F_3 of two crosses, *viz.*, E.B. 171 \times E.B. 417 and E.B. 177 \times E.B. 417, the virescent parents being E.B. 171 and E.B. 177, while the normal green parent was E.B. 417. The back cross generation was also studied in the case of E.B. 171 \times E.B. 417. The F_1 and F_2 genera-

* Accession numbers given to the exotic barley types in the collection at the Indian Agricultural Research Institute.

TABLE I
Distinguishing characters of the parents

Variety	Chlorophyll deficiency	Anthocyanin pigment in			Black melanin-like pigment in			
		Leaf-sheath	Node	Auricle	Lemma	Pericarp	Outer glume	Awns/hoods
E.B. 171 ..	Virescent	White	White	White	White	White	White	White awns
E.B. 177 ..	"	"	"	"	"	"	"	"
E.B. 417 ..	Green	Purple	Purple	Purple	"	"	"	"
E.B. 438 ..	"	"	"	"	"	"	"	"
E.B. 132 ..	"	Black	Black	Black	Black	Black	Black	Black hoods
K. 251 ..	"	White	White	White	White	White	White	White awns
C. 138-2 ..	"	"	"	"	"	"	"	"

tions of these crosses were studied for 2 years. During the year 1956-57, all virescent seedlings died before they could form grains. Therefore, there were no F_3 progenies of virescent plants. However, the progenies of normal green plants of the F_2 generation were studied in F_3 . The segregation ratios observed in the F_2 , B_1 and F_3 generations in the different crosses are presented in Tables II (a) and (b).

The data given in Tables II (a) and (b) show that in the F_1 , normal green was dominant over the virescent seedling in both the crosses. In the year 1956-57, the F_2 segregation showed a good fit to a monohybrid ratio in the crosses studied. During 1957-58, although the back-cross and the F_3 data were in conformity with the monohybrid ratio of segregation, the F_2 segregation showed a poor fit, there being an excess of normal green seedlings and deficit of virescent ones in each case.

2. Inheritance of purple leaf-sheath colour

The crosses, E.B. 171 \times E.B. 417 and E.B. 177 \times E.B. 417 were studied for this character. The details of the segregations observed in the different generations are given in Tables III (a) and (b).

The parent E.B. 417 has a deep purple leaf-sheath colour. The F_1 , in both the crosses, was deep purple. In the F_2 , a wide range of variation in the intensity of the colour was observed but only two classes viz., purple and white were taken into consideration. In the cross E.B. 171 \times E.B. 417, B_1 , F_2 and F_3 segregations gave good fit to a

TABLE II

Inheritance of Virescence (Chlorophyll Deficiency) in the seedlings
 (a) *Classification of parents, F₁, F₂ and back cross*

Year of Study	Material	Number of Plants		Total	X ²	P. Value
		Normal green	Vire-scent			

1956-57						
Cross: E.B. 171 × E.B. 417						
	E.B. 417	36	..	36		
	F ₁	6	..	6		
	F ₂ —Observed	489	143	632		
	Expected (3:1)	474	158		1.896	.20-.10
	E.B. 171	..	24	24		
Cross: E.B. 177 × E.B. 417						
	E.B. 417	25	..	25		
	F ₁	7	..	7		
	F ₂ —Observed	485	170	655		
	Expected (3:1)	491.25	163.75		0.318	.70-.50
	E.B. 177	..	36	36		

1957-58						
Cross: E.B. 171 × E.B. 417						
	E.B. 417	33	..	33		
	F ₁	11	..	11		
	F ₁ × E.B. 171—					
	Observed	18	14	32		
	Expected (1:1)	16	16		0.5	.50-.30
	F ₂ —Observed	487	109	596		
	Expected (3:1)	447	149		14.54	Very low
	E.B. 171	..	20	20		
Cross: E.B. 177 × E.B. 417						
	E.B. 417	36	..	36		
	F ₂ —Observed	451	123	574		
	Expected (3:1)	430.5	143.5		3.928	.05-.02
	E.B. 177	..	36	36		

(b) Classification of F_3 Families

Material	Number of lines			Total	X ²	P. Value
	Normal green	Segregating	Virescent			

<i>Cross: E.B. 171</i>						
<i>× E.B. 417</i>						
F ₃ —Observed	34	67	..	101		
Expected						
(1: 2)	33.67	67.33	..		0.005	.95-.90

<i>Cross: E.B. 177</i>						
<i>× E.B. 417</i>						
F ₃ —Observed	34	62	..	96		
Expected						
(1: 2)	32	64	..		0.187	.70-.50

TABLE III

Inheritance of purple leaf-sheath and node colour
 (a) Classification of parents F_1 , F_2 and back cross

Material	Number of Plants		Total	X ²	P. Value
	Purple	White			

<i>Cross: E.B. 171 × E.B. 417</i>					
E.B. 417	33	..	33		
F ₁	11	..	11		
F ₁ × E.B. 171—					
Observed	10	11	21		
Expected (1:1) ..	10.5	10.5		0.048	.90-.80
F ₂ —					
Observed	425	123	548		
Expected (3:1) ..	411	137		1.907	.20-.10
E.B. 171 .. ..	..	15	15		

<i>Cross: E.B. 177 × E.B. 417</i>					
E.B. 417	40	..	40		
F ₂ —					
Observed	382	100	482		
Expected (3:1) ..	361.5	120.5		4.65	.05-.02
E.B. 177 .. ..	..	20	20		

(b) Classification of F_3 Families

Material	Number of lines			Total	X ²	P. Value
	Purple	Segregat- ing	White			

Cross: E.B. 171
× E.B. 417

F ₃ —						
Observed ..	31	38	30	99		
Expected						
(1: 2: 1) ..	24.75	49.5	24.75		5.36	.10–.05

Cross: E.B. 177
× E.B. 417

F ₃ —						
Observed ..	30	42	22	94		
Expected						
(1: 2: 1) ..	23.5	47	23.5		2.425	.30–.20

monohybrid ratio. In the other cross, $E.B. 177 \times E.B. 417$, the F_2 segregation showed a poor fit (0.02–0.05) but the fit was good in the F_3 generation.

3. Inheritance of purple node colour

The mode of inheritance of this character was studied in three crosses. The data for the crosses $E.B. 171 \times E.B. 417$ and $E.B. 177 \times E.B. 417$ have been presented in Tables III (a) and (b) and the details of the segregations in the cross $K. 251 \times E.B. 438$ are given in Table IV.

TABLE IV

Inheritance of purple node colour in the cross $K. 251 \times E.B. 438$
Classification of parents, F_1 and F_2 plants

Material	Number of plants		Total	X^2	P. Value
	Purple	White			
K. 251 ..		28	28		
F_1 ..	12		12		
F_2 —					
Observed ..	254	106	360		
Expected (3: 1)	270	90		3.793	.10-.05
E.B. 438 ..	22		22		

A perusal of Tables III and IV shows that purple colour in the nodes was dominant over white in the F_1 generation in all the crosses and was controlled by one simple Mendelian factor.

4. Inheritance of purple auricle colour

The cross E.B. 171 \times E.B. 417 was studied in the F_1 , F_2 , F_3 and B_1 generations with regard to this character. The data are presented in Tables V (a) and (b).

TABLE V

Inheritance of purple auricle colour in the cross E.B. 171 \times E.B. 417

(a) *Classification of parents, F_1 , F_2 and back cross*

Material	Number of plants		Total	X^2	P. Value
	Purple	White			
E.B. 171 ..	..	15	15		
F_1	11	..	11		
$F_1 \times$ E.B. 171—					
Observed ..	9	9	18		
Expected (1 : 1)	9	9		0	1.0
F_2 —					
Observed ..	394	122	516		
Expected (3 : 1)	387	129		0.507	.40-.30
E.B. 417 ..	33	..	33		

(b) *Classification of F_3 Families*

Material	Number of lines			Total	X^2	P. Value
	Purple	Segregating	White			
F_3 —						
Observed .. 8	15	6	29			
Expected (1 : 2 : 1) ..	7.25	14.5	7.25		0.241	.90-.80

Purple colour in the auricle was dominant in the F_1 . The F_2 , F_3 and B_1 segregations showed a good fit to a simple monohybrid ratio of 3 purple: 1 white.

5. Inheritance of black melanin-like pigment

The inheritance of black pigmentation in the lemma and pericarp, outer glumes and awns (or hoods) was studied in the crosses, K. 251 \times E.B. 132 and C. 138-2 \times E.B. 132. In the case of the black grained parent E.B. 132, the lemma, outer glumes and hoods were also black, while in the white grained parents, C. 138-2 and K. 251, these parts were non-pigmented. The segregations in the F_2 , F_3 and B_1 generations are summarized in Tables VI (a) and (b).

TABLE VI

Inheritance of black pigmentation in the lemma, pericarp, outer glume and awns

(a) *Classification of parents, F_1 , F_2 and back crosses*

Material	Number of plants		Total	X ²	P. Value
	Black	White			

Cross: K. 251 × E.B. 132

E.B. 132	..	..	15	..	15		
F ₁	...	..	7	..	7		
F ₁ × E.B. 132	..	..	50	..	50		
F ₁ × K. 251—							
Observed	..	..	47	55	102		
Expected (1: 1)	..	..	51	51		0.627	.50-.30
F ₂ —							
Observed	..	..	462	143	605		
Expected (3: 1)	..	..	453.75	151.25		0.578	.50-.30
K. 251	..	..	..	15	15		

Cross: C. 138-2 × E.B. 132

E.B. 132	..	..	15	..	15		
F ₁	..	..	18	..	18		
F ₂ —							
Observed	..	..	450	151	601		
Expected (3: 1)	..	..	450.75	150.25		0.0006	.99-.98
C. 138-2	..	..	..	37	37		

(b) Classification of F_3 families

Material	Number of lines			Total	X ²	P. Value
	Black	Segregat- ing	White			

Cross: K. 251
× E.B. 132

F ₃ —						
Observed	..	21	47	22	90	
Expected (1:2: 1)	..	22.5	45	22.5	0.2	.95-.90

Cross: C. 138-2
× E.B. 132

F ₃ —						
Observed	..	26	40	14	80	
Expected (1:2: 1)	..	20	40	20	3.6	.20-.10

Black colour in the lemma, pericarp, outer glumes and hoods was dominant in the F_1 . The F_2 , B_1 and F_3 segregations showed a good fit to a simple monohybrid ratio of 3 black: 1 white for each of the characters studied. In the segregating populations, a black grained plants was always found to possess black colour in the lemma, outer glumes and hoods or awns, whereas in none of the white grained plants was the black pigment observed in any of these plant parts.

In E.B. 132, the straw developed black pigmentation towards maturity. The leaf-sheath, node and auricle also had the same pigmentation. But the expression of the colour was not uniform which made the study of the segregation of these characters in these crosses difficult.

DISCUSSION

In the two crosses studied for chlorophyll deficiency, the normal green condition was found to be dominant in the F_1 . The F_2 segregation was studied for 2 years, viz., 1956-57 and 1957-58. In the first year, the F_2 showed a good fit for 3 normal green: 1 virescent. The F_2 segregation during 1957-58, however, did not show a good fit to this ratio due to the occurrence of lesser number of virescent seedlings than what is expected on the basis of 3:1 segregation. The virescent seedlings, due to their poor vigour, are more likely than normal ones to readily

succumb to adverse conditions in the soil. Daane (1931) observed a similar type of discrepancy while studying the inheritance of virescence. His observations indicated that the seeds producing normal green plants had a higher percentage of germination than those which carried the chlorophyll deficient gene. In the present investigation, the deviation in the ratio seems to be due to either poor germination of the seeds with the gene for virescence or failure of the seedlings to emerge out of the soil. The plot on which this material had been grown during 1957–58 developed bad alkali patches and it was very likely that this had caused higher mortality of seeds and seedlings carrying the gene for virescence as compared to normal seeds and seedlings. Segregation in the F_3 families and back-cross generation clearly confirmed that virescence behaved as a simple recessive character. Robertson and Deming (1930), Daane (1931), Robertson *et al.* (1932), Robertson and Coleman (1940) and others also found similar segregation of normal vs. virescence, indicating a single factor difference.

In the two crosses studied for the inheritance of purple leaf-sheath colour the deep purple colour of E.B. 417 was dominant in F_1 . The F_2 segregation showed a wide range of variation with regard to the intensity of pigment development. The range varied from deep purple to light purple and white. In some cases only a few purple streaks were seen. When grouped into two classes, *viz.*, purple and white, the F_2 , F_3 and B_1 segregations in the cross E.B. 171 \times E.B. 417 showed a good fit to a simple monohybrid ratio. In the cross E.B. 177 \times E.B. 417 the F_2 showed a poor fit to this ratio. But in F_3 the segregation clearly indicated that the purple colour in this cross also was controlled by one factor. The slight deviation from the 3:1 ratio in the F_2 generation of this cross was presumably due to wrong classification of some plants. Taken as a whole, the results of segregation in the two crosses clearly confirm the assumption of one factor difference. Robertson (1933) found that purple straw was dominant over white and was controlled by one gene. The appearance of plants with different intensities of pigmentation suggests that in addition to the main gene responsible for development of the pigment, there may be some intensifier genes controlling the expression of this character.

The inheritance of purple node colour was studied in the two crosses mentioned above and a third one, *viz.*, K. 251 \times E.B. 438. The analysis of the data indicated a clear case of segregation on a monohybrid basis, purple being dominant in the F_1 generation. In the crosses E.B. 171 \times E.B. 417 and E.B. 177 \times E.B. 417 analysis of combined segregation of leaf-sheath colour and node colour in the F_1 , F_2 , F_3 and B_1 revealed that purple colour in the node was always associated with purple colour in the leaf-sheath. It may, therefore, be concluded that either the same gene was responsible for the colour in the leaf-sheath and the node or the two genes controlling the development of the pigment in these two parts were very closely linked. This finding does not seem to have been reported by previous workers.

The F_1 of the plants of the cross E.B. 171 \times E.B. 417 had purple auricles like those of E.B. 417. The back-cross, F_2 and F_3 data clearly indicated that this character was controlled by one gene. Huber (1929) found the presence or absence of red pigment in the auricle to segregate in 3:1 and 10:6 ratios in different crosses. The inheritance of black 'flowering glume' colour was studied by a number of workers. Black was found to be completely dominant over white, the F_2 segregation ratio being 3 black:1 white (Biffen, 1907; Sigfusson, 1929; Buckley, 1930; Danne, 1931; Hanson and Kramer, 1949; Litzenberger and Green, 1951, etc.). The results obtained in the present investigation are in agreement with those of previous workers. The F_1 in both the crosses studied for this character showed dominance of the black colour of E.B. 132. Segregations in F_2 , F_3 and B_1 showed good fit to simple monohybrid ratios. Biffen (1907) and Buckley (1930) noted that black vs. white pericarp behaved similarly and that black colour in the hulls was associated with colour in the pericarp. The results of the present studies are in line with these findings. The data further showed that in the segregating populations, colour in the grains also caused black pigmentation in the outer glumes and awns (or hoods). In the white grained plants all these parts were non-pigmented. There was no exception to this. This clearly shows that either it is a case of pleiotropy or that the different genes controlling the development of this pigment in different plant parts are very closely linked.

SUMMARY

The mode of inheritance of a chlorophyll deficiency (virescence) and development of anthocyanin as well as melanin-like pigment in various plant parts was studied through F_1 , F_2 and F_3 generations in 5 crosses, viz., E.B. 171 \times E.B. 417, E.B. 177 \times E.B. 417, K. 251 \times E.B. 438, K. 251 \times E.B. 132 and C. 138-2 \times E.B. 132. In some crosses the back cross generation was also studied. Presence or absence of anthocyanin pigmentation was studied in the leaf-sheath, node and auricle, whereas the development of melanin-like pigmentation was studied in the lemma, pericarp, outer glumes and awns.

The characters taken up for this investigation, segregated in a simple Mendelian manner, normal green being dominant over the virescent and the anthocyanin or melanin-like pigmentation being dominant over white. The results further indicated that in addition to the main gene responsible for the development of anthocyanin pigment in the leaf-sheath, there were, perhaps, some minor genes which controlled the intensity of pigmentation.

The results have clearly indicated that the development of anthocyanin pigmentation in the leaf-sheath and the node was controlled by the same gene or very closely linked genes. The same was the case with the development of the melanin-like pigment in the lemma and pericarp, outer glumes and awns.

ACKNOWLEDGEMENTS

We are grateful to Dr. B. P. Pal, Director, I.A.R.I., New Delhi, for the interest he has all along shown in this work.

Our thanks are due to Mr. J. S. Bakshi for assistance in the early stages of these studies.

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INDIAN SPECIES OF *RAUVOLFIA*

BY (Miss) C. B. SULOCHANA

The University Botany Laboratory, Madras-5

(Received for publication on July 1, 1959)

IN recent years, considerable interest has been focussed on the chemistry and the physiological activities associated with the alkaloids of *Rauvolfia serpentina* Benth. (see Woodson *et al.*, 1957). Based on initial experimentation, it was believed that these alkaloids would probably supplement and/or replace preparations from *Veratrum viride* Ait., for the alleviation of human suffering from high blood pressure. Indeed, reserpine is now widely used in the treatment of hypertension and as a tranquilizing agent, and is administered effectively against tachycardia. Three absorbing phases of the problem have been locating the regions where the plant grows in abundance, ascertaining the most advantageous season of the year for collection and estimating the distribution. The present article is based on a critical survey carried out in the Western Ghats area of Bombay, Goa, Madras, Coorg, Mysore and Kerala States, in Uttar Pradesh and in Himalayan Terrain. Collections of other species of *Rauvolfia* were made from Southern Indian zones. While endeavouring to identify the species, it was found that the earlier recordings were somewhat inadequate and confusing. A revision has, therefore, been attempted herein by comparing my collection of specimens with those available at the Madras Herbarium, Coimbatore, at the University College, Trivandrum, and at the Herbarium, Indian Botanic Gardens, Sibpur, Calcutta, reference being made to available literature. Another intriguing problem arising as a result of mixing a whole range of adulterants in the commercial supply of the so-called *R. serpentina* roots, required experimentation in order to enable sifting of the pure material. The adulterants consist not only of related rauwolfias but also of other groups which, however, can easily be eliminated by gross macroscopical differences. A comparative anatomical study has been made, as the microscopical differences often prove helpful in identifications and are necessary to establish the botanical identity of commercial crude drug samples, playing an important role in checking adulteration, substitutions and fraud.

HISTORICAL

Ancient Hindu literature (*Dhanvantri Vaidya Sastram* and other treatises) details use of *Rauvolfia serpentina* Benth., termed "Sarpa-gandha" in Sanskrit, for treatment of insomnia, epilepsy, insanity, rheumatism, blood-pressure, asthma and intestinal infections. It is also supposed to cause uterine contraction and promote expulsion of foetus in the same manner as ergot of rye. Application of this drug

is made in several ways. It is given with *Aristolochia indica* L. for cholera; along with *Andrographis paniculata* Nees., ginger and black salt for relief of fever; along with *Holarrhena antidysenterica* Wall., and *Jatropha curcus* L. in milk for colic; and as fresh root for total cure of asthma. It is much esteemed as an antidote for snake-bites and scorpion stings, given as a decoction and powder applied directly to the affected part, but opinion appears divided on this point. Rumphius speaks of this under the name *Radix mustelæ* (Watt, 1892) as being widely used in India and Java as an internal remedy against fevers, cholera and dysentery, and of the juice of the leaves instilled into the eyes as a remedy for removal of opacities of the cornea. It is also stated that this is the plant to which the mongoose is believed to have recourse when bitten by poisonous snakes. Javanese refer to the plant as "pulepandak", classing it under their anthelmintics. In Bombay labourers who used to come from Konkan kept a small supply of the root for relief of bowel pains. According to the folklore, women in the villages of Bihar value this root as a charm to keep off evil omens and as an effective sedative for their babies during their engagement in the field.

TAXONOMY

Rauwolfia (Plum.) L., *Sp. Pl.* ed., 1: 208, 1753; *Gen. Pl.* ed. 5: 98, 1754; Pichon, in *Bull. Soc. bot. Fr.* 94: 32, 1947; L. *Gen. Pl.* ed. 8 (Reichard): 118, 1778 (as *Rauwolfia*); L. *Gen. Pl.* ed. 8 (Schreber): 160, 1789; L. *Sp. Pl.* ed. 4 (Willdenow): 1217, 1798; A. DC. in DC. *Prod.* 8: 336, 1844; Benth. & Hook., *Gen. Pl.* 2: 637, 1876; K. Sch. in Engl. & Prantl, *Nat. Pflanzenfam.* 4²: 153, 1895 (as *Rauwolfia*).

(Synonyms: *Ophioxylon* L., *Gen. n.* 1142; *Fl. Zeyl.*, 239, 1747; *Sp. Pl.* ed. 1: 1043, 1753.

Dissolæna Lour., *Fl. Cochinch.*, 137, 1790.

Crytosiphonia Miq., *Fl. Ind. Bat.* 2: 401, 1856.

Heurckia Muell., Arg., in *Flora, Jena* 53: 168, 1870).

The genus consists of a large number of species, chiefly tropical American. The New World has about 30 well recognised species in addition to 12 doubtful species (Rao, 1956). *Rauwolfia serpentina* Benth., *R. densiflora* Benth., *R. beddomei* Hook. f. and *R. micrantha* Hook. f. constitute the Indian species while *R. tetraphylla* L., a West Indian species, runs wild, chiefly in the port towns along the Indian coastline. This species has been known to have been introduced to India more than a century ago (Voigt, J. O., *Hort. suburb. Calcut. Cat. Pl.* 202, 1845).

Lactescent, glabrous, herbaceous or woody shrubs with dichotomous branches. Leaves 3-5-nately whorled, rarely opposite, simple, entire, petiolate or sessile, penninerved, nerves slender, arched, axils glandular. Inflorescence terminal, lateral or interpetiolar, sometimes

geminate, dichotomously branched, bracteate, lax or compact dichasia. Flowers pedicellate or sessile, salver-shaped, tube cylindric, dilated opposite the stamens, mouth constricted, glabrous externally, variously pilose within, lobes broad, overlapping to the left. Stamens epipetalous included at or above the middle of the corolla tube, anthers small, acute, rounded at the base. Disc large, cup-shaped or annular. Pistil superior, carpels 2, distinct or connate, style filiform at the base, tip bifid, ovules 2, collateral in each carpel. Ripe carpels drupaceous, distinct or connate, usually one-seeded. Seeds ovoid, embryo erect, albumen fleshy, cotyledons 2, flat.

KEY TO THE SPECIES

- A. Herbaceous undershrub, 6-18" tall, sparsely lenticellate, compact dichasia, pedicels and calyx red, corolla tube slender, inflated a little above the middle.
 - B. Leaves thin, in whorls of 3, lanceolate, margin wavy, main nerves rather distant, oblique; flowers c. 1" long, corolla tube purplish, petals white, calyx lobes short; drupes slightly connate, obliquely ovoid, pyrenes slightly rugose ... 1. *R. serpentina*
- AA. Woody shrubs, stems lenticellate, leaves slightly anisophyllous, dichasia rather lax, flowers small, corolla tube broad, inflated at the top, drupes apocarpous or syncarpous only at the base.
 - C. Drupes ellipsoid, distinct.
 - D. Large shrub, up to 12' tall, stem copiously lenticellate, leaves oblanceolate, in whorls of 3-4, pale beneath, main nerves many, sub-horizontal, regular; corolla tube 0.5" long, lobes round, calyx lobes long and slender, peduncles 1-2" long, geminate, drupes distinct, ellipsoid, pyrenes very rugose and pointed ... 2. *R. densiflora*
- CC. Drupes divergent, ovate acute, joined to the middle.
 - E. Dichotomously branched shrub, 5-6' tall, minutely

lenticellate, leaves oblanceolate, coriaceous, in whorls of 3, main nerves many, close and regular; cymes very lax, few flowered, on single peduncles, c. 4" long, divaricate branches long and slender, flowers 0.25" long, drupes 0.3" long, pyrenes large, slightly rugose 3. *R. beddomei*

EE. Slender shrub minutely lenticellate, leaves small, elliptic-lanceolate or oblanceolate, long acuminate, in whorls of 3, main nerves very slender, cymes lax, few flowered, peduncles 1.5" long, often two together, corolla-tube somewhat unexpanded, 0.2" long, drupes 0.2" long, pyrenes rugose 4. *R. micrantha*

AAA. Woody shrubs, leaves pubescent, strikingly anisophyllous, inflorescence few flowered umbellate cymes, drupes ovoid, joined to the top.

F. Leaves ovate or ovate-elliptic, acute or obtuse, abruptly tapering at the base, tomentose on both surfaces, umbellate cymes on short peduncles, few flowered, calyx lobes short, rounded, ciliate, corolla-tube short, c. 0.1", lobes rounded, unexpanded; drupes ovoid, 0.2" long, pyrenes rugose 5. *R. tetraphylla*

1. *Rauvolfia serpentina* Benth.

Gen. Pl. 2: 697, 1876; Hook., *Fl. Brit. Ind.* 3: 632, 1882; Kurz, *For. Fl.* 2: 17, 1877; *Ophioxylon serpentinum* Linn. in DC. *Prodr.* 8: 342, 1844; *Bot. Mag. t.* 784; Jones in *As. Research*, 4: 208; Roxb., *Fl. Ind.* 1: 233, 1820; Roxb., *Fl. Ind. ed. Carey and Wall.* 2: 530, 1824; Wt., *l.c.* 3, t. 849; Garh., *Cat. Bomb. Pl.*, 116, 1839; Dalz and Gibs., *Bomb. Pl.* 144, 1861.; Bedd., *For. Fl. Anal. Gen.* 156; Miq., *Fl. Ind. Bat.* 2: 404, 1856; *O. trifoliatum* Gaertn., *Fruct.* 2: 129; t. 109, fig. 2; Miq. *l.c.*; *O. obversum* Miquel, *l.c.*, 405; *Tabernamontana cylindraria* Wall., *Cat.* 4451; Rheede, *Hort. Mal.* 1, t.

47; Burmann, *T. Zeyl. t. 64*, 1737; Gamble, *Fl. Madras Pres.* 5: 807, 1921; Drury, *For. Fl.* 2: 190, 1866 (Pl. XVII, Fig. 19).

VERNACULAR NAMES

Bengali and Hindi: *Chota-chand*, *Chundrika*, *Dhavathana varuva*, *Chandramakha*, *Dhanamakha*, *Isargath*; Burmese: *Bongmaiza*; Canarese: *Garudapathal*; Javanese: *Pulepandak*; Malayalam: *Amalpori*, *Chuvanna avilpori*; Malay: *Chandra*, *Karavi*, *Haraki*; Marathi: *Hadki*, *Moogsavel*, *Sapsan*, *Pagalkadhava*; Orissa and Bihar: *Patalgarur*, *Dhanmarna*, *Dhanbarna*, *Isargath*, etc.; Sanskrit: *Sarpagandha*, *Chundrika*, *Kshermakshi*; Sinhalese: *Aika-Wariya*, *Eka-Wariya*, *Rat-eka-Wariya*; Tamil: *Eiyakundu*; Telugu: *Patalagandhi*, *Patala-garuda*, *Patalagani*.

Rauvolfia serpentina is a perennating herb with a cluster of branches (2-8) arising from the root which is large for the size of the plant. Root system consists of a prominent tuberous, soft taproot, 0.5-2.5" in diameter, sometimes irregularly nodular. The main root grows vertically down tapering after a length of 2-2.5', the thin wiry root continuing to grow to a depth of 6-8'. Outer bark is corky with irregular longitudinal fissures; the central core, 0.5-2.0" across, showing well-defined radiating xylem rays, centric xylem plate and concentric growth rings, is encircled by a soft bark, 0.1-0.4" wide, pink in most and white in others (Pl. XVI, Figs. 6, 6a); colour of the bark is clearly preserved in dry state also. Fresh roots smell acrid and taste very bitter. These roots form the natural source of significant amounts of the active principle "Reserpine". Stem: terete, rarely lenticellate. Leaves: 3-7" \times 1½-2½", in whorls of three, occasionally 1-5 at each node, thin, lanceolate, narrowed into a short petiole, acute or acuminate, main nerves rather distant, 8-12 pairs, oblique. The shoot usually withers away in the hot dry spell from January to May, and with the onset of the South-west Monsoon, new shoot primordia develop from the primary root. Inflorescence: many-flowered compact cymes, 1-2" in diameter, closely corymbose on single peduncles 2-5" long, branches and pedicels becoming bright red as the first fruits start developing. Bracts: obsolete, red; calyx tube: lobes (5) short, imbricate. Corolla-tube: long, slender, inflated a little above the middle, about 1" long. Stamens: 5, enclosed within the dilated portion of the tube, filaments very short. Carpels: 2, connate. Fruit: drupe, obliquely ovoid, c. 0.25", long purplish-black, pyrenes, very slightly rugose (Pl. XVI, Fig. 14).

In nature, dispersal is facilitated by birds, the hard pyrenes germinating on being thrown out with the excreta and by displacement of bits of roots by water currents. Vegetative propagation by stem and root cuttings is effective. Seeds have a low germination rate of 15 per cent. or less, and require pre-treatment for proper germination.

Specimens Examined.—Collections made by me from the following localities during 1952-53: Puliya (Shencotta District); Balamore, Perunchani, Kulasekharam, Pechupara, Madathuraikani, Thenmalai,

Ariankavu, Edamen, Paravandhoor, Punnalai, Koni, Naduvothamuzhi, Kodamen, Achenkoil, Ranni, Kottayam, Erumely, Kanjarappalli, Chalakudy, Trichur, Perumbavoor, Kalady (Travancore and Cochin, Kerala State); Shoranur, Mundur, Kongad, Mannarghat, Tiruvizhankunnu, Nilambur, Kannothe, Wynaad (Malabar, Kerala State); Anamalais, Hanametti, Kollegal (Coimbatore District); Parappa, Sullia, Sampaje, Subramanya, Uppinangadi, Karkala, Sitanadhi, Thingle, Sankaranarayana, Hosangadi, Baindur (South Kanara); Bhatkal (North Kanara); Nagar, Hosnagar, Arsalu, Shimoga (Mysore); Yellapur Londa, Supa, Dandelli, Dingua (Bombay State); Rajaji Reserve, Haridwar (Uttara Pradesh); Dharbhanga (Himalayan Terrain); the following specimens from the Herbarium, Indian Botanical Gardens, Calcutta, were also examined:

1. Koni, Travancore, Dec. 1894, No. 423, T. F. Bourdillon.
2. Koni, Travancore, Sept. 1904, No. 2239.
3. Nellacotta, Nilgiris, 4000', Oct. 1910, No. 11458, A. Meeblod.
4. Elwar, S. Malabar, 700', March 1910, No. 1827, C.E.C. Fischer.

Distribution.—*Rauvolfia serpentina* Benth. is widely distributed from the Himalayas South to Ceylon and East to Thailand and in Java. It is indigenous to Bombay, Goa, Coorg, Madras, Mysore, Travancore-Cochin, East Punjab, Uttar Pradesh, Bihar, Orissa, Bengal and Assam States in India and to East Pakistan, Burma, Malaya, Northern areas in Thailand, Java, Andamans and Ceylon. The plants are inhabitants of moist regions with a rainfall range of 60–150" a year and altitudes up to 3000'. Along the west-coast strip from Konkan southwards to Thadikkarankonam in South Travancore—the area critically surveyed by me—plentiful occurrence of *R. serpentina* is more or less continuous, the plants growing in red and black soil zones, as well as on hard laterite, more at the foot of the ghats in open, cleared areas and in those areas where the surface vegetation gets burnt annually in post-monsoon periods and occasionally extending to the seacoast, as in Goa and North Canara. On the eastern slopes of the Western Ghats locations of interest are few and isolated in places where there are gaps in the range, as the Anamalais and Walayar reserves off the Palghat gap, parts of Shencottah and Tinnevely districts off the Ariyankavu pass in the extreme South and in parts of Hassan and Shimoga districts of Mysore State.

There is little difference in the morphological features of this species in all these zones. Nonetheless, microclimatic and edaphic factors appear to influence the quality of the roots, as evidenced by the variation in the alkaloid content and potencies of roots obtained not only from representative and geographically distinct areas but also from lots coming from the same geographical areas (Rajagopalan, 1954).

2. *Rauvolfia densiflora* Benth.

Gen. Pl. 2: 697, 1876; Hook., *Fl. Brit. Ind.* 3: 632, 1882; Cooke, *Fl. Pres. Bomb.* 2: 127, 1908; Gamble, *Fl. Madras*

Pres. 5: 807-08; 1921; *R. decurva* Hook. f., *Fl. Brit. Ind.* 3: 632, 1882; *O. neilgherrense* Dalz. & Gibs., *Bomb. Pl.* 144, 1861; *O. neilgherrense*, *Wt. Ic.* 4 (2): 1292, 1850; *Bedd., Fl. Sylv.* 156; *Bedd., Fl. Sylv. Anal. Gen. clvi*, 1873 (Text-Fig. 1).



TEXT-FIG. 1. *Rauvolfia densiflora* Benth. From living plant.

A very large shrub reaching 12' or more, copiously lenticellate. Root: Hard, woody, brown, bitter. Leaves: often in whorls of 3-4, very variable in size, 4-10" \times 2-3", oblanceolate or obovate, acuminate; main nerves many, 8-16 pairs, prominent, sub-horizontal intramarginal vein prominent; Inflorescence: many, bifurcating corymbose cymes, often numerous, rather lax; peduncles dichotomously branching, 1-2" long. Flowers: white. Calyx: sepals elongate, subulate, lanceolate, nearly half the length of the broadly tubular corolla, which is inflated at the top. Corolla-tube: about 0.5" long, lobes large and rounded. Stamens: 5, included. Fruit: drupes brownish, purple, obliquely ellipsoid, distinct; pyrenes very rugose, compressed, pointed at the top (Pl. XVI, Fig. 15).

Published literature indicates sharp distinctions in vegetative characters with reference to this species in different locations in Southern India. *R. decurva* Hook f., initially considered a distinct species, is now included as a form of *R. densiflora* Benth. (Talbot, 1911).

Description.—Shrub, branches stout lenticellate, leafy at the tips only, leaves small 1-1½" \times ½-¾" in crowded whorls (Pl. XVI, Fig. 13). Cymes short, peduncle ½-1", 2-6-flowered, flowers small, white to pink. Calyx lobes lanceolate, half as long as the corolla-tube. This variety, reported from Bombay Presidency, is easily distinguishable by the small leaves crowded at the tips of woody branches, decurved peduncles and small flowers. Cook (*loc. cit.*), however, states that he has found both decurved and erect peduncles on the same plant.

Specimens Examined.—Include personal collections from Mahabaleshwar (1951 and 1953) and Anmode (1952) in Bombay State and the following from the Indian Botanic Garden, Calcutta:—

1. Vandenmettu, Travancore, 4000-5000', Dec. 1910, No. 13180 A. Meeblod.
2. Scipaca Ghat, Nilgiris, 4000', May 1884, No. 14337. J. S. Gamble.
3. Devicolam, Travancore, 6000-7000', Dec. 1910, No. 13601, J. S. Gamble.
4. Poonda, Belgaum District, 2000', Oct. 1900, No. 4322, W. A. Talbot.
5. Ainshi Ghat, North Canara, May 2nd, 1885, No. 1190, W. A. Talbot.
6. No. 602 (incomplete), S.H. College, Shembaganur, Madura District.

Distribution.—Himalayas—Khasia mountains, 1400'; Deccan Peninsula in the Western Ghats from Konkan Southwards to Ceylon—in Nilgiris, Pulneys, Anamalais, and Hills of Tinnevely and Travancore-Cochin States, alt. 4000-7000'; Eastern Ghats—Rumpu Hills, Godavari, 4000'.

Therapeutically this plant seems to have little value.

Apart from the synonyms mentioned earlier, Wight (Wt., *Ic.* 4: Pt. II, 1850) recorded the following species, namely, *Ophioxylon ceylonicum*, *O. macrocarpum*, and *O. belgaumense* as allied to *R. densiflora* Benth., but showing differences in floral characters:—

Ophioxylon ceylonicum (R.W.), collected in 1836 near Neuera Ellia in Ceylon, is allied to *R. densiflora* Benth., but appearing quite distinct in having 2 ovules in each carpel and the drupes connate at the base (Wt., *Ic.* 4: Pt. II, 1850).

Ophioxylon macrocarpum (R.W.)—Pulney Hills; distinguished by its large fruit, nuts of which are $\frac{1}{2}$ " long, obovate, slightly compressed, tubercle (Wt., *spicil.* 2: 53, 1851; Wt., *Ic.* 4: 1850).

Ophioxylon belgaumense (R.W.), allied to the Alpine group, but quite distinct from the preceding ones, in having compact inflorescences, very numerous capitate alabastra and broad, somewhat truncated lobes of the Calyx (Wt., *spicil.* 2: 53, 1851; Wt., *Ic.* 4: 1850).

No collection of any of the above three specimens has been reported subsequently.

3. *Rauvolfia beddomei* Hook f.

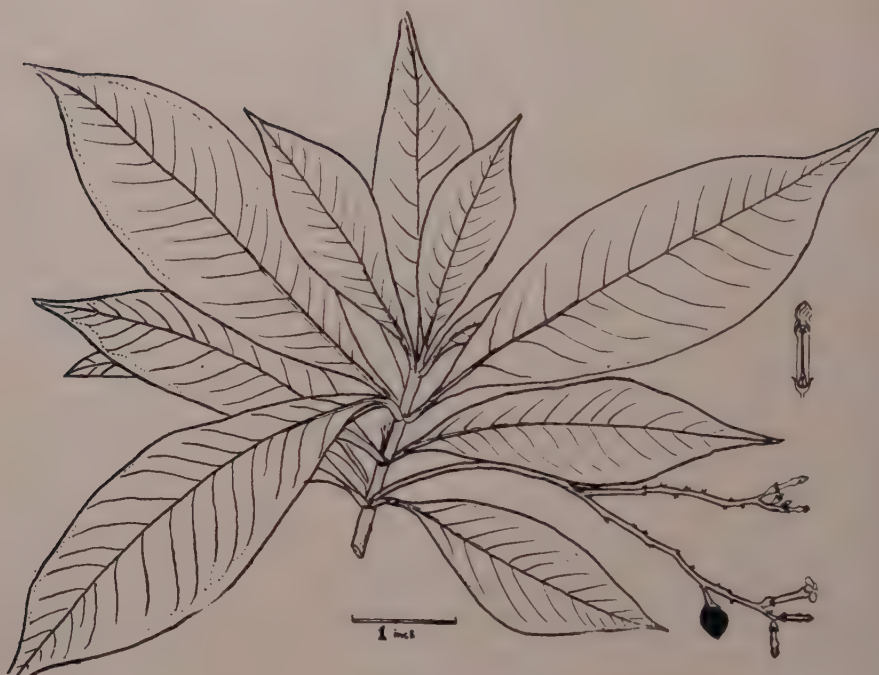
Hook., *Fl. Brit. Ind.* 3: 634, 1882; Gamble, *Fl. Madras Pres.* 5: 807–08; 1921. [Synonym: *Tabernaemontana verticellata* Bedd., *Fl. Sylv. Anal. Gen. clix.* pl. 20: fig. 3, 1873] (Text-Fig. 2).

Dichotomously branched, glabrous shrub 5–6' tall; Root: stout, corky, surface glistening, fissure longitudinal and irregular, tastes very bitter; Stem: minutely lenticellate; Leaves: 3–6" \times 1 $\frac{1}{2}$ –1 $\frac{3}{4}$ ", nerves many, close, regular, sub-horizontal; Inflorescence: lax cymes, peduncles 2–4" long, divaricate branches; Calyx: Triangular, ovate; Corolla-tube 0.5" long, 0.1" broad, slightly swollen at the top, lobes small, expanded, ovate, long, petals pinkish white, lilac at the throat of the tube; Stamens: 5, included; Carpels: 2, pointed, connate, one or both carpels developing into drupes. Drupes gibbously ovate, acute, pyrenes $\frac{1}{3}$ – $\frac{1}{5}$ ", prominently rugose (Pl. XVI, Fig. 16).

Specimens Examined.—Include personal collections from Thodupuzha (1951), Erumely (1953), Kodanad (1953), Travancore-Cochin, Kerala State) and the following from the Indian Botanic Gardens, Calcutta.

1. Palaruvi Hills, South Travancore, Sept. 9, 1913, No. 797.
2. Thalapara Hills, South Travancore, Sept. 9, 1912, No. 1740, M. Rama Rao.

In both the above specimens (Nos. 797 and 1740) the drupes are double, connate and pointed, contrary to the description of solitary drupes in the species by Hooker (*loc. cit.*).



TEXT-FIG. 2. *Rauvolfia beddomei* Hook.f. From living plant.

Distribution.—Western Ghats, Hills of Tinnevely and Travancore-Cochin up to 2000'.

4. *Rauvolfia micrantha* Hook. f.

Hook., *Fl. Brit. Ind.* 3: 633, 1882; Gamble, *Fl. Madras Pres.* 5: 807-08, 1921. (Synonym: *Ophioxylon micranthum*, Wight. Mss.) non *R. micrantha* K. sch. (Text-Fig. 3).

Slender shrub, branches with many small lenticels; Root: woody, hard, yellowish brown, bitter; Leaves: elliptic, narrowed into an often slender petiole; main nerves 10-12 pairs, slender; Inflorescence: cymes slender, with few flowers; Flowers: $\frac{1}{4}$ - $\frac{3}{8}$ " long; Calyx lobes triangular, about $\frac{1}{4}$ the length of the corolla-tube; Corolla-tube: white, short, narrow, dilated at the top, yellowish to lilia at the throat of the tube 0.2". Stamens: 5, included; Fruit: drupes, connate to the middle, obliquely ovate, acute, pyrenes, slightly rugose, somewhat compressed in the upper half (Pl. XVI, Fig. 17).

Specimens Examined.—Include specimens collected at Kottayam (1951, 1953); Punnalai, near Punalur (1953); Pathanapuram (1953); Chenganachery (1953), Travancore-Cochin, Kerala State and the specimen mentioned below from the Indian Botanic Gardens, Calcutta.



TEXT-FIG. 3. *Rauvolfia micrantha* Hook.f. From Sheet No. 1323, M. Rama Rao, July 22, 1913.

Parampuzha, Travancore, July 22, 1913; No. 1323, M. Rama Rao.

Distribution.—Kottayam, Koni, Quilon forest divisions in Travancore, Kerala State—below 1000'.

Distribution of *R. beddomei* Hook. f., and *R. micrantha* Hook. f., is endemic in the Southern Zone of the Western Ghats. The later is

less common than the former. Roots of these are supposed to have medicinal properties comparing well with those of *R. serpentina* Benth., and are widely employed by the native Ayurvedic physicians of South Malabar, Travancore and Cochin in Kerala State.

5. *Rauvolfia tetraphylla* L.

Sp. Pl. 208, 1753. (Synonyms: *R. subpubescens* Linn., *Mant.* 2: 345; *R. tomentosa* Jack, *Enum. Pl. Carib.*, 14; *R. hirsuta* Jack., *Enum. Pl. Carib.*, 14; *R. canescens* Linn., *Sp. Pl. ed. 2*: 303, 1762). (Text-Fig. 4.)



TEXT-FIG. 4. *Rauvolfia tetraphylla* L. From living plant.

Small, branched woody shrub, reaching up to 4' in height minutely lenticellate; Root: woody, hard, bark dark-brown, surface corrugated with a few fissures; Leaves: 3-5-natley whorled, mostly 4 in each whorl, of very unequal sizes, $\frac{1}{2}$ - $3\frac{1}{2}$ " by $\frac{1}{2}$ - $1\frac{1}{2}$ ", elliptic, acute, pubescent, main nerves about 10 pairs; Inflorescence: few flowered, axillary, umbellate cymes, peduncles 0.25-0.75"; Flowers: small, cream white; Calyx: lobes short, ciliate; Corolla-tube 0.15" long, broad, dilated at the top, lobes short, rounded, unexpanded; Stamens: 5, included; Fruit: drupes, deep purple (red when unripe), joined to the top, ovoid, 0.25" long, pyrenes, rugose, oblong (Pl. XVI, Fig. 18).

Specimens Examined.—Include my collections from Madras Calicut, Mangalore and Waltair from South India during 1952-53 and the following from the Indian Botanic Gardens, Calcutta:—

1. Janardhan, Diamond Harbour, Aug. 27, 1899.
2. Shaik Mokim, Sibpur, Aug. 15, 1902.

Distribution.—Common weed in the vicinity of the port towns along the Indian coastline.

ANATOMY

It is now well recognised that systematic anatomy, based on accurately named material and with good written descriptions, is of economic importance as it enables botanical materials to be identified even when floral characters are lacking (Metcalf, 1946; Rendle, 1943; Wallis, 1943). In order to offer tangible basis for identification of commercial samples, descriptive reports on the anatomy of various species of *Rauvolfia* have been published by several workers (Esdorn and Schmitz, 1956; de Toledo and Grotter, 1956; Woodson *et al.*, 1957; Youngken, 1953, 1954, 1955, 1956). Most detailed account is that given by Woodson (*see* Woodson *et al.*, 1957), who distinguished 23 species of *Rauvolfia*, based on anatomical characters and simple microchemical tests. He also gives a provisional key, but as the study was on only 23 species out of a total of about 40 species, he could not, however, associate definite anatomical characteristics with Pichon's (1947) 14 sections of this genus.

The work reported here is based on a detailed study of a large number of samples of the Indian species of *Rauvolfia*. Specimens of dry roots neatly cut and polished, on being boiled for 15 minutes in 0.01 per cent. aqueous picric acid solution, renders the structure of the cross-section favourably comparable with that of fresh material as the distinctions in the visual features of the bark and wood are brought out clearly by this treatment (Pl. XVI, Figs. 7-12). Microtome sections (10-25 μ thick) of sun-dry, comparable root samples (*c.* 1.25 cm. diam.) of all five species of *Rauvolfia* collected during field trips in 1952-53 were prepared by previously softening the materials by treating with dilute hydrofluoric acid (Sass, 1940). Thin slivers of the roots were macerated following Jeffrey's method (*i.e.*, soaking in equal volumes of 10 per cent. chromic acid and nitric acid mixture at 30-35° C. for 24 hours) for studying the structure of fibres.

1. *Rauvolfia serpentina* root shows thick striated bark and uniformly wide, white or pink coloured phelloderm-bast region devoid of mechanical tissue. The secondary xylem is characterized by straight rays, close, concentric growth rings and centric xylem plate.

Histology

Periderm.—Phellum: brown, striations close, many, mean width 876μ , 4–10 rows of cells in each striation. Phelloderm: parenchyma with starch grains, mean width 876μ . Secondary phloem: mean width 730μ , starch grains present.

Secondary Xylem.—Wedges narrow, straight, interspaced with wide vascular rays (Pl. XV, Fig. 1). Xylem vessels: in narrow frequently uniseriate wedges radiating from the centre outward, mean tangential diam. 36.5μ , mean radial diam. 51μ , pitted. Xylem fibres: curved and variously shaped, short with somewhat beaded lignification, $307\text{--}526\mu \times 15\text{--}44\mu$ (Text-Fig. 5 A, a, B, b). Vascular rays: prominent, $73\text{--}365\mu$ wide, 4–10 rows of cells, cell size $15\text{--}58\mu \times 22\text{--}73\mu$. Average 4 rays in 1 mm. (tangentially); starch grains abundant. Terminal apotracheal parenchyma: absent. Xylem plate: centric.

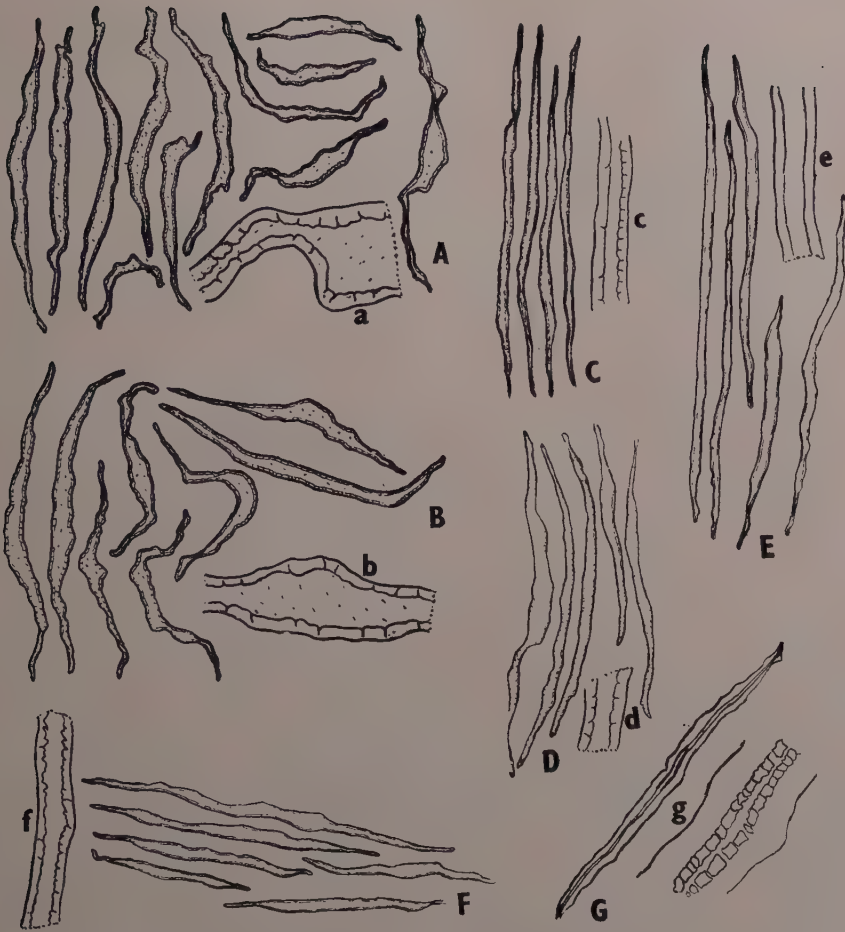
2. *Rauvolfia densiflora* root shows striated bark, and narrow phelloderm-bast region, brown when dry, whitish when fresh. The secondary xylem is characterized by wide growth rings—the root easily breaking along the lines in between the growth rings—curved rays and excentric xylem plate.

Histology

Periderm.—Phellum: brown, striations 3–10, mean width 584μ , 10–15 rows of cells. Phelloderm: parenchyma with starch grains, mean width 584μ ; Secondary phloem: mean width 730μ , starch grains, sclereides and solitary rhomboidal crystals present.

Secondary Xylem.—Xylem wedges numerous, narrow, curved, alternating with narrow vascular rays (Pl. XV, Fig. 2). Xylem vessels: mean tangential diam. 36.5μ , mean radial diam. 43.8μ pitted. Xylem fibres: numerous, elongate, fairly uniformly lignified, $832\text{--}920\mu \times 29\text{--}36\mu$ (Text-Fig. 5, C, c). Vascular rays: narrow, $44\text{--}51\mu$ wide, 1–5 rows of cells, cells $12\text{--}45\mu \times 12\text{--}45\mu$, starch grains present. Average 9 rays in 1 mm. (tangentially); Terminal apotracheal parenchyma: present, separating the growth rings, $58\text{--}88\mu$ wide, cells thin-walled, 4–7 rows. Xylem plate: excentric.

3. *Rauvolfia beddomei* root shows very thick prominently striated bark, which differs from other roots in having a glisten on the surface, and brown phelloderm-bast region (pink when fresh); devoid of mechanical tissue. The secondary xylem shows a characteristic arrangement of the curved rays and excentric xylem plate.



TEXT-FIG. 5. Xylem fibres from macerated roots of:

- (A) *R. serpentina* (bark—white), $\times 70$, *a* $\times 350$
- (B) *R. serpentina* (bark—pink), $\times 70$, *b* $\times 350$
- (C) *R. densiflora*, $\times 50$, *c* $\times 250$
- (D) *R. beddomei*, $\times 50$, *d* $\times 250$
- (E) *R. micrantha*, $\times 50$, *e* $\times 250$
- (F) *R. tetraphylla*, $\times 50$, *f* $\times 250$
- (G) Sclereid from bast of *R. tetraphylla* root, $\times 50$, *g* $\times 250$.

Histology

Periderm.—*Phellum*: brown, striation many, mean width $1,460\mu$, about 24 rows of cells in each. *Phelloderm*: mean width 430μ ; *Secondary phloem*: mean width 384μ , definite rays present.

Secondary Xylem.—Xylem wedges prominent, curved, characteristically arranged, intervening vascular rays wide (Pl. XV, Fig. 3). Xylem vessels: mean tangential diam. 51μ ; mean radial diam. 73μ , pitted. Xylem fibres: slightly curved, lignification uniform slightly beaded; $584-920\mu \times 24-55\mu$; (Text-Fig. 5, D, d). Vascular rays: wide; $58-233\mu$ in width, 1-6 rows of tangentially broad cells, cell size $22-52\mu \times 44-116\mu$, average 6 rays in 1 mm. (tangentially); Starch grains abundant. Terminal apotracheal parenchyma: absent. Xylem plate: excentric.

4. *Rauvolfia micrantha* root shows thin bark and narrow brown (white when fresh) phelloderm-bast region. The secondary xylem has numerous closely arranged curved rays and excentric xylem plate.

Histology

Periderm.—Phellum: Yellowish brown, striations 2-5, mean width 370μ , 7 to 10 rows of compressed cells in each. Phelloderm-bast region: mean width 146μ , stone fibres present. Secondary phloem: mean width 146μ , crystalline inclusions and sclereides present.

Secondary Xylem.—Xylem wedges numerous, narrow, closely arranged, alternating with narrow, often uniseriate vascular rays (Pl. XV, Fig. 4). Xylem vessels: mean tangential diam. 44μ , mean radial diam. 44μ , pitted. Xylem fibres: numerous, elongate, $628-716\mu \times 22-37\mu$, uniformly lignified (Text-Fig. 5, E, e). Vascular rays: mostly uniseriate, sometimes 2-4 row of cells present, cell size $22-44\mu \times 29-36\mu$, average 8 rays in 1 mm. (tangentially); Starch grains present. Terminal apotracheal parenchyma: prominent, as much as 130μ wide, cells up to 10 rows. Xylem plate: excentric.

5. *Rauvolfia tetraphylla* root shows hard, narrow outer bark with few indistinct striations, and brown, hard, wide phelloderm-bast region. The secondary xylem has numerous large vessels, curved rays and somewhat excentric xylem plate.

Histology

Periderm.—Phellum: dark brown, striations 1-3, indistinct, mean width 156μ . Phelloderm: solitary and clusters of sclereides present (Text-Fig. 5, G, g), mean width 436μ . Secondary phloem: mean width 584μ . Crystalline aggregates present.

Secondary Xylem.—Diffuse porous (Pl. XVI, Fig. 5). Xylem vessels: large, mean tangential diam. 73μ , mean radial diam. 110μ , pitted. Xylem fibres: many, elongate, narrow slightly bent with beaded lignification. $438-978\mu \times 29-53\mu$ (Text-Fig. 5, F, f). Vascular rays: narrow, 2-4 rows of radially elongate cells, $29-102\mu \times 15-22\mu$, average 3 rays in 1 mm. (tangentially), starch grains present. Terminal apotracheal parenchyma: present as one prominent band following the third or fourth growth ring, cells 3-4 rows. Xylem plate: slightly excentric.

Structure of the secondary xylem of roots of the Indian species of *Rauvolfia* shows a general similarity in the regular radial arrangement of numerous xylem wedges alternating with prominent vascular

rays, while the introduced species, namely *R. tetraphylla* L. shows typical diffuse, porous secondary xylem with numerous large vessels. In general, xylem wedges consist of narrow-lumened and relatively fewer vessels, with xylem fibres occurring in radial linear rays. From these observations it can be seen that the anatomical details of the roots of the five species studied are distinct enough to enable easy recognition of one from the other. In view of the predominant storage function in the case of *R. serpentina* Benth., and *R. beddomei* Hook. f.—the structure of which shows the nearest approach to that of the former—the secondary xylem is chiefly composed of extensive sheets of storage parenchyma forming wide, multiseriate vascular rays. The presence of short fibres in the wood renders *R. serpentina* root easily breakable. The dense secondary xylem of *R. densiflora* Benth., and *R. micrantha* Hook. f., is characterized by the abundant formation of fibres in the xylem wedges which are interspaced with narrow vascular rays.

A key based on the anatomical characters, that are sufficiently fixed to be of taxonomic significance, of the roots of *Rauvolfia* spp., for enabling identification of the species within the genus, in the absence of flowering shoots or data on vegetative characters of the specimens to be determined, is given below:—

A. Secondary xylem composed of radial linear xylem wedges.

B. Terminal apotracheal parenchyma absent.

C. Xylem plate centric; growth rings close, prominent; xylem fibres curved, variously shaped and short; vascular rays multiseriate, composed of 4–10 rows of cells; bark striated and thick .. 1. *R. serpentina*

CC. Xylem plate excentric, growth rings wide, xylem wedges curved and characteristically arranged, fibres, long; vascular rays of 1–4 rows of large cells; bark striated, very thick and with a glisten .. 2. *R. beddomei*

BB. Terminal apotracheal parenchyma present.

D. Bark brown, striations many (3–10), solitary rhomboidal crystals present; growth rings very wide, terminal apotracheal parenchyma narrow (58–88 μ), vascular rays multiseriate (1–5 rows) .. 3. *R. densiflora*

- DD. Bark yellowish brown, striations few (2-5), sclereides and crystalline inclusions (prismatic aggregates and twinned) present; growth rings narrow, successive terminal apotracheal parenchyma present, prominent (up to 130μ wide), vascular rays often uniseriate .. 4. *R. micrantha*

AA. Secondary xylem diffuse porous.

- E. Vessels large, numerous; vascular rays narrow cells small and radially elongate; solitary and clusters of sclereides and crystalline inclusions present in the bark; bark narrow hard, striations indistinct and few 5. *R. tetraphylla*

Morphologically, *R. serpentina* Benth. and *R. densiflora* Benth. have distinct specific characters while *R. beddomei* Hook. f., and *R. micrantha* Hook. f. which have a restricted distribution chiefly in Travancore-Cochin show close affinity to each other. The root anatomy reveals similarities between *R. beddomei* Hook. f., and the low altitude species of *R. serpentina* Benth., and between *R. micrantha* Hook. f., and the alpine species of *R. densiflora* Benth.

SUMMARY

1. Descriptive and distributional accounts and illustrations of *R. serpentina* Benth., *R. densiflora* Benth., *R. beddomei* Hook. f., *R. micrantha* Hook. f., and *R. tetraphylla* L. are given.

2. A comparative anatomical study of the roots of Indian *Rauvolfia* spp., has been made and key based on the distinguishing anatomical features that enable specific diagnosis is presented.

ACKNOWLEDGEMENTS

This work was carried out under the Riker Research Laboratories Scheme for a study of this genus during 1952-53 under the direction of the late Dr. S. Rajagopalan to whom I am very grateful for his kind advice and helpful criticisms. I wish to record here my grateful thanks to Prof. T. S. Sadasivan, Director, University Botany Laboratory, Madras, for giving me the opportunities to complete this investigation, to the Director, Indian Botanic Gardens, Sibpur, Calcutta, for placing at my disposal their collection, and to the States' Forest Personnel for their ready field assistance in the various forest tracts. My sincere thanks are due to Prof. P. Maheshwari, Professor of Botany, University

of Delhi and to Dr. H. W. Youngken, Research Professor of Pharmacognosy and Botany, Massachusetts College in U.S.A., for critically going through the manuscript of this paper.

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EXPLANATION OF PLATES

PLATE XV

FIGS. 1-4. Photomicrographs of secondary xylem of *Rauwolfia* roots (v: vascular ray), $\times 91$.

FIG. 1. *Rauwolfia serpentina*.

FIG. 2. *Rauwolfia densiflora*.

FIG. 3. *Rauwolfia beddomei*.

FIG. 4. *Rauwolfia micrantha*.

PLATE XVI

FIGS. 5-18

FIG. 5. Photomicrograph of secondary xylem of *Rauvolfia tetraphylla* root, $\times 91$.

FIGS. 6, 6a. Transverse sections of fresh *R. serpentina* roots. Fig. 6. With pink phelloderm-bast region; Fig. 6a. White phelloderm-bast region, $\times 1.5$.

FIGS. 7-12. Transverse sections of dried roots, $\times 2$. Fig. 7. *R. tetraphylla*. Fig. 8. *R. beddomei*. Fig. 9. *R. serpentina* (Phelloderm-bast region white). Fig. 10. *R. densiflora*. Fig. 11. *R. serpentina* (Phelloderm-bast region pink). Fig. 12. *R. micrantha*.

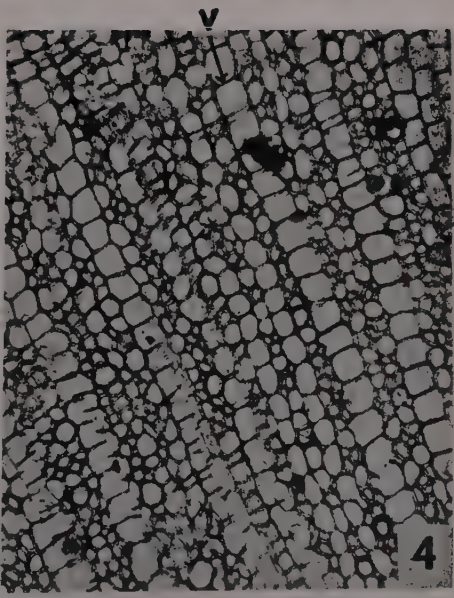
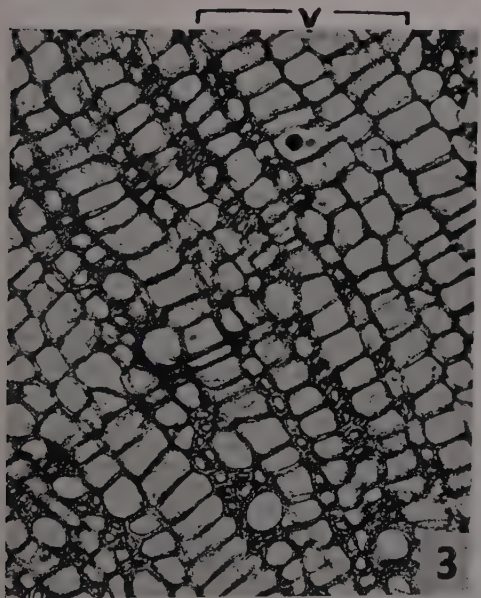
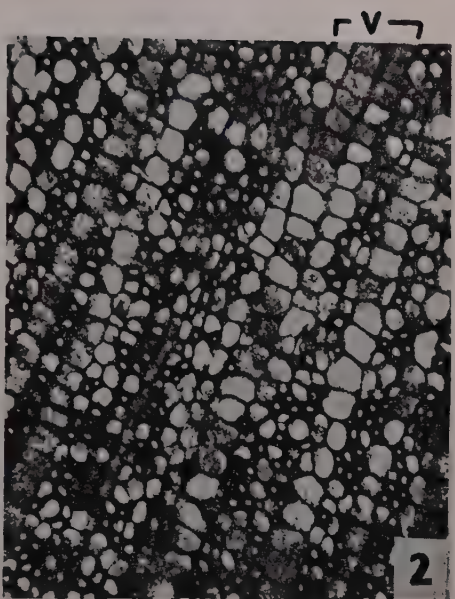
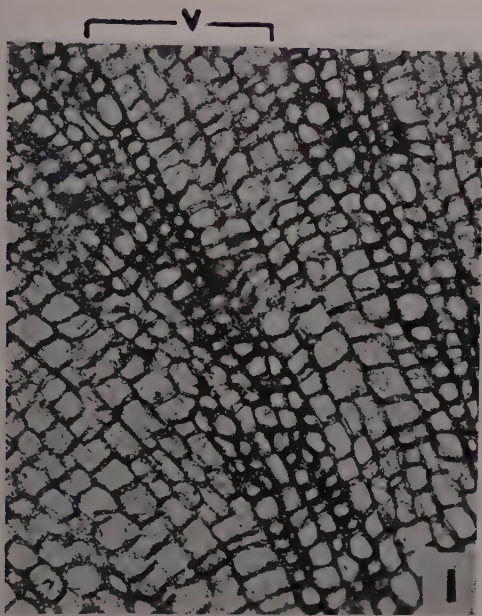
FIG. 13. Flowering shoot of *R. densiflora* var. *decurva* Benth. From Sheet No. 1190, W. A. Talbot, May 1885.

FIGS. 14-18. Pyrene of *R. serpentina*, $\times 1.5$. Fig. 15. Pyrene of *R. densiflora*, $\times 1.5$. Fig. 16. Pyrene of *R. beddomei*, $\times 1.5$. Fig. 17. Pyrene of *R. micrantha*, $\times 1.5$. Fig. 18. Pyrene of *R. tetraphylla*, $\times 1.5$.

PLATE XVII*

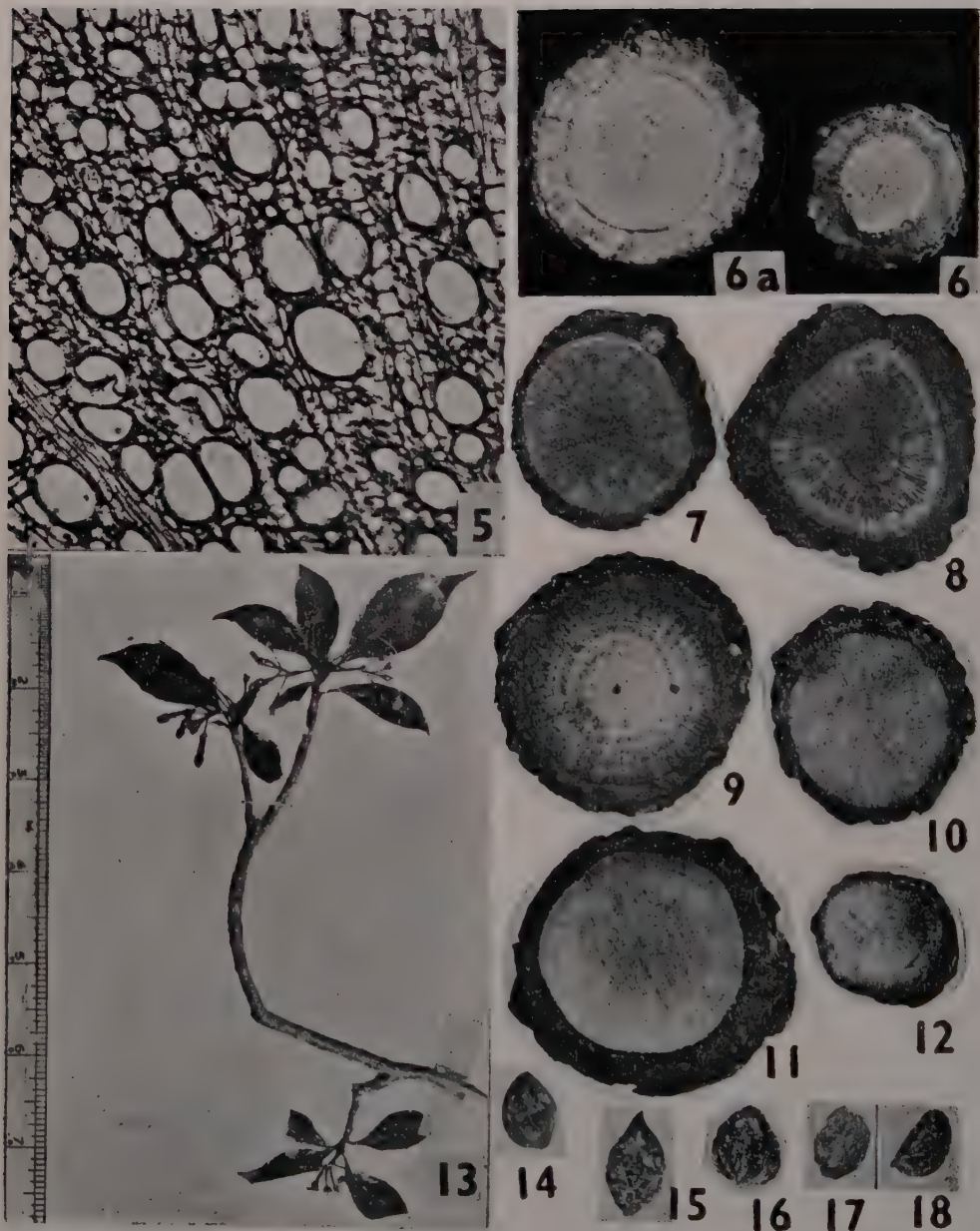
FIG. 19. *Rauvolfia serpentina* Benth. From living plant.

* Colour plate was kindly supplied by the author.



C. B. Sulochana

FIGS. 1-4



C. B. Sulochana

FIGS. 5-18



FIG. 19

C. B. Sulochana



REVIEW

Nomenclature of Plants. A text for the application by the Case Method of the International Code of Botanical Nomenclature, BY HAROLD ST. JOHN. (The Ronald Press Company, New York), 1959. 20×13.5 cm; pp. vii + 157. Price \$2.50.

The International Code of Botanical Nomenclature is of fundamental importance for all botanists engaged in taxonomic studies; a thorough understanding of its rules and recommendations is essential for any botanist who may wish to describe any new findings. The Code has been very carefully prepared, its articles or rules have been expressed in terms that may leave no room for any misunderstanding; at least this has been the aim of the various committees of international experts, who have helped in the framing of the Code.

Unfortunately, among botanists there are many who cannot study the Code, as due to the limited editions of the same, copies are seldom available; or alternatively, they find the various rules so complicated as to judge the latter almost unintelligible. The book under review aims at making students familiar with the provisions of the Code.

The book is just a collection of cases to be given to students as problems or exercises in the application of the various rules of nomenclature. Naturally this is a subject for advanced or post-graduate students; in our universities the book may perhaps be beyond the reach of even such students, since the subject has been almost completely excluded from our syllabi. My experience, however, with Bombay students has convinced me that the subject is of great interest and can be mastered fairly easily with a little care and study.

In the introduction the author discusses in detail one case of nomenclature, listed in the body of the book under No. 721, i.e., *Pyrus cydonia* Linn.; step by step, and with reference to the various articles of the Code, the author lists the various names given to this plant, the Quince-tree, from 1753 onwards. This is a very detailed study, to show readers how the cases listed in the book can and should be studied.

The 958 cases given in the book in Chapters 2-7 deal with the application of the laws of botanical nomenclature. Some cases refer only to the spelling of the names; others to the Rule of Priority; others to homonyms, tautonyms, etc. In some of the more complicated or disputed cases, references are given to recent publications, where the case may have been discussed by experts.

On purpose the author has omitted keys or solutions to the problems. "The discussion as to the correct solution of each case is left freely open to each class, with the professor and students acting as judge and jury." This is satisfactory for such students as may have easy access

to the bibliographic references, or at least to the more important references, given in the book. I have found the book very interesting; and to prove its usefulness, have given some of the cases to my research students; most cases so given have been correctly solved.

Considering, however, that most of our universities possess but a very limited library, I would earnestly request the author to prepare a companion volume giving the correct solution to his cases; such a volume might appear superfluous for American universities, but I feel sure that many of the less prosperous universities all over the world would thankfully welcome its publication.

As part of the introduction the author lists "a selection of the most serviceable" publications, which should be available to users of the book. The book closes with a complete index of all the scientific names listed under the various cases. The presentation and printing are of a very high class.

H. SANTAPAU.



GIRIJA PRASANNA MAJUMDAR (1894-1959)

PROFESSOR G. P. MAJUMDAR, 1894-1959

WE deeply regret to record the sad demise of Professor G. P. Majumdar, a distinguished Botanist of India, on the 21st November 1959, at his Calcutta residence. In his death the country has lost a noble soul, a true patriot, an able professor and a distinguished scientist.

Professor Majumdar was born on 18th February 1894 at Gopalnagar, Pabna District (now in East Pakistan). He passed the Entrance Examination in 1909 from Pabna Zilla School and came to Calcutta for higher education and obtained the M.Sc. degree in Botany in 1915 standing first in order of merit. In 1914 when he was an M.Sc. student, he joined the teaching staff of the Botany Department, Presidency College, Calcutta. From 1928 he was associated with the post-graduate department of the Calcutta University. In 1938 he went to Leeds, England, on study leave to work on plant anatomy under late Professor J. H. Priestley and obtained the Ph.D. degree of the University of Leeds in 1940. He retired from the Presidency College in 1949, but his services were soon requisitioned by the West Bengal Government for the organisation of Honours teaching in Botany at the Government College, Darjeeling.

In December 1951, Dr. Majumdar was appointed Professor of Botany and Head of the Biology Department, Dacca University (East Pakistan) which post he held for about three years. While in Pakistan he acted as the Chairman of the Commission of Courses of the Karachi University. He also presided over the Section of Biology, Zoology, Botany and Entomology at the Annual Session of the Pakistan Association for Advancement of Science in 1955.

Professor Majumdar was a keen research worker and worked till the end of life. He was the foremost worker on developmental plant anatomy in this country. During his stay in England, he in collaboration with Dr. Preston (now Professor Preston), studied the X-ray diffraction pattern of cell-walls of collenchymatous cells. The exact nature of many morphological structures was revealed by extensive developmental and anatomical studies carried out by him and his students in Calcutta and he published a large number of papers in scientific journals in India and abroad. Professor Majumdar also made extensive researches on the genesis and development of Botany and Agriculture in ancient India and his contribution to the subject was unique in its kind in this country. After collecting data from many Sanskrit texts he compiled an excellent and authoritative account about botanical science in ancient India for which the Griffiths Prize of the Calcutta University was awarded to him in 1925. This text was later published as *Botany in Ancient India*. He edited and translated the *Upavana Vinoda*, an ancient text on arbori-horticulture in India and also edited the *Krishi Parasara*, a Sanskrit text on agriculture, which is under publication by the Asiatic Society. He also published a book on *Some Aspects of Indian Civilization in Plant Perspective*. Dr. Verdoon of

Chronica Botanica, Massachusetts, U.S.A., invited him to write a volume on the *History of Botany in India* but he could not undertake the work due to ill-health.

Professor Majumdar was one of the few Indian scientists who could write on difficult scientific topics in lucid Bengali for young readers. He wrote the entire portion regarding plant and plant life for the *Sishu-bharati* (Children's Encyclopedia in Bengali) edited by Jogendra Nath Gupta. He also published several scientific articles in Bengali in *Prakriti*, a scientific journal edited by Dr. S. C. Laha. He published several scientific primers for children and also published a book on science called *Prathamik Bijnan* in collaboration with Professor Charu Chandra Bhattacharjee.

As a Professor, Dr. Majumdar was very successful. He used to inspire his students with new ideas and was held in great esteem by all his students, many of whom are now occupying high positions in the universities and in Government departments.

Professor Majumdar had been associated with various scientific bodies of the country. He was Fellow of the National Institute of Sciences of India, Indian Academy of Sciences and the Indian Botanical Society. He presided over the Section of Botany, Indian Science Congress in 1945 and over the Section of Technical Sciences, All-India Oriental Conference in 1947. He was the President of the Indian Botanical Society in 1949, Vice-President in 1950 and Secretary, Treasurer and Editor-in-Chief in 1942-44, 1944 and 1948-49 respectively. He was also the President of the Botanical Society of Bengal from 1947 to 1948. He was for sometime Vice-President of National Institute of Sciences of India, Biological Secretary of the Asiatic Society and the Joint Editor of Publications, National Institute of Sciences of India. For a short period he officiated as the Secretary of the Asiatic Society and during this period he tried to introduce various improvements in its functioning.

As a man, Professor Majumdar was most unassuming and had a charming personality. He had a nationalistic bent of mind and had been actively associated with several national organisations. Except during the two years he had been in England, he never wore anything except hand-spun and woven clothing. He was a generous man and used to help many poor boys in many ways.

For the last one year Professor Majumdar was not keeping good health. In spite of his ill-health his interest in research continued unabated and he had been carrying on work on developmental anatomy with the help of a research assistant under the scheme of aid to retired scientists, sponsored by the Council of Scientific and Industrial Research. He was planning to write a review on the *Stipules of Plants* but his end came suddenly and the work was left unfinished. He died of heart failure at 9 A.M. on the 21st November 1959.

B. C. KUNDU.

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Professor Majumdar was a keen research worker and worked till the end of life. He was the foremost worker on developmental plant anatomy in this country. During his stay in England, he in collaboration with Dr. Preston (now Professor Preston), studied the X-ray diffraction pattern of cell-walls of collenchymatous cells. The exact nature of many morphological structures was revealed by extensive developmental and anatomical studies carried out by him and his students in Calcutta and he published a large number of papers in scientific journals in India and abroad. Professor Majumdar also made extensive researches on the genesis and development of Botany and Agriculture in ancient India and his contribution to the subject was unique in its kind in this country. After collecting data from many Sanskrit texts he compiled an excellent and authoritative account about botanical science in ancient India for which the Griffiths Prize of the Calcutta University was awarded to him in 1925. This text was later published as *Botany in Ancient India*. He edited and translated the *Upavana Vinoda*, an ancient text on arbori-horticulture in India and also edited the *Krishi Parasara*, a Sanskrit text on agriculture, which is under publication by the Asiatic Society. He also published a book on *Some Aspects of Indian Civilization in Plant Perspective*. Dr. Verdoon of

Chronica Botanica, Massachusetts, U.S.A., invited him to write a volume on the *History of Botany in India* but he could not undertake the work due to ill-health.

Professor Majumdar was one of the few Indian scientists who could write on difficult scientific topics in lucid Bengali for young readers. He wrote the entire portion regarding plant and plant life for the *Sishu-bharati* (Children's Encyclopedia in Bengali) edited by Jogendra Nath Gupta. He also published several scientific articles in Bengali in *Pra-kriti*, a scientific journal edited by Dr. S. C. Laha. He published several scientific primers for children and also published a book on science called *Prathamik Bijnan* in collaboration with Professor Charu Chandra Bhattacharjee.

As a Professor, Dr. Majumdar was very successful. He used to inspire his students with new ideas and was held in great esteem by all his students, many of whom are now occupying high positions in the universities and in Government departments.

Professor Majumdar had been associated with various scientific bodies of the country. He was Fellow of the National Institute of Sciences of India, Indian Academy of Sciences and the Indian Botanical Society. He presided over the Section of Botany, Indian Science Congress in 1945 and over the Section of Technical Sciences, All-India Oriental Conference in 1947. He was the President of the Indian Botanical Society in 1949, Vice-President in 1950 and Secretary, Treasurer and Editor-in-Chief in 1942-44, 1944 and 1948-49 respectively. He was also the President of the Botanical Society of Bengal from 1947 to 1948. He was for sometime Vice-President of National Institute of Sciences of India, Biological Secretary of the Asiatic Society and the Joint Editor of Publications, National Institute of Sciences of India. For a short period he officiated as the Secretary of the Asiatic Society and during this period he tried to introduce various improvements in its functioning.

As a man, Professor Majumdar was most unassuming and had a charming personality. He had a nationalistic bent of mind and had been actively associated with several national organisations. Except during the two years he had been in England, he never wore anything except hand-spun and woven clothing. He was a generous man and used to help many poor boys in many ways.

For the last one year Professor Majumdar was not keeping good health. In spite of his ill-health his interest in research continued unabated and he had been carrying on work on developmental anatomy with the help of a research assistant under the scheme of aid to retired scientists, sponsored by the Council of Scientific and Industrial Research. He was planning to write a review on the *Stipules of Plants* but his end came suddenly and the work was left unfinished. He died of heart failure at 9 A.M. on the 21st November 1959.

B. C. KUNDU.

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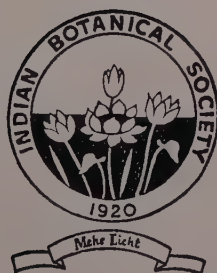
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THE INDIAN BOTANICAL SOCIETY

PROCEEDINGS OF THE ANNUAL MEETING, 1959



BANGALORE CITY
PRINTED AT THE BANGALORE PRESS, MYSORE ROAD
1959

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THE INDIAN BOTANICAL SOCIETY

MINUTES OF THE THIRTY-EIGHTH ANNUAL MEETING OF THE GENERAL BODY

THE THIRTY-EIGHTH ANNUAL GENERAL BODY MEETING of the Indian Botanical Society was held on 21st January 1959, at 5-30 P.M., in the New Botany Lecture Theatre (F), Botany Department, University Buildings, Delhi-8, with Prof. R. Misra in the Chair.

The following members were present:—

Mr. R. S. Chopra, Dr. K. S. Thind, Mr. S. N. Dixit, Dr. R. Narayana, Mr. R. N. Kapil, Mr. M. C. Joshi, Dr. T. V. Desikachary, Dr. E. K. Janaki Ammal, Dr. T. Sreeramulu, Mr. A. Seshagiri Rao, Mr. S. Suryanarayanan, Mr. A. C. Sahgal, Dr. D. D. Pant, Dr. Gadadhar Misra, Prof. B. Samantarai, Dr. I. K. Vasil, Mr. T. Kabi, Dr. C. V. Subramanian, Mr. M. V. Mirashi, Dr. S. Chitale, Dr. Satish Chandra Gupta, Mr. G. P. Agarwal, Dr. S. C. Pandeya, Mr. I. P. Bahri, Mr. Raj K. Gupta, Mr. S. K. Jain, Mr. R. Bose, Dr. P. Parija, Mr. M. R. Sharma, Prof. P. Maheshwari, Dr. S. K. Pande, Dr. P. N. Mehra, Dr. B. M. Johri, Dr. K. S. Bhargava, Dr. Y. S. Murty, Mr. T. S. Trivedi, Dr. P. C. Joshi, Dr. K. Subrahmanyam, Dr. M. Ananthaswamy Rao, Mr. M. G. Panchaksharappa, Mr. R. S. Ambasht, Mr. H. P. Mehta, Mr. S. C. Gupta, Mr. S. Naik, Prof. R. Misra, Prof. T. S. Sadasivan, Prof. J. Venkateswarlu, besides several visitors including Dr. C. A. Arnold.

1. The minutes of the 37th Annual General Body Meeting held at Madras-5, on 6th January 1958, at 11 A.M., were read and confirmed.

2. The Annual Report of the Society for the year 1958 as approved by the Executive Council was read and adopted.

3. The Audited Statement of Accounts for the period from 1-4-1957 to 31-3-1958 already circulated to members as Proceedings of the Society, 1958 was considered and approved. The Treasurer's efforts in raising the funds of the Society were appreciated.

Budget Estimates for the year 1959-60 were presented by Prof. T. S. Sadasivan, the Hon. Treasurer. The same were considered by the House and passed.

4. The following resolutions which were given due notice of by Prof. T. S. Sadasivan were discussed and passed:

(a) Ordinary Members may become Life-Members upon payment of Rs. 250 either in lump sum or in instalments within a year from the time of their application for Life-Membership provided that any Ordinary Member who has already paid a number of annual subscriptions may be allowed a rebate at the rate of half the annual subscription paid, up to a maximum of eight years.

(b) Ordinary Members shall pay an admission fee of Rs. 5 on joining the Society. The annual subscription of Ordinary Members shall be Rs. 20. This shall be due on the first day of each calendar year and shall be paid in advance to the Treasurer.

(c) The subscription to the Journal from non-members shall be Rs. 30 or £ 2-10-0 or \$ 7.50.

(d) The President and Vice-Presidents shall serve for one year each and the Secretary, the Treasurer and Councillors for three years. The Councillors who have been in office for a term of three years shall retire from the Council and shall not be eligible for re-election until after the lapse of one year from the date of their retirement. The time of retirement of Office-bearers shall be 31st January in the concerned years and the new Office-bearers shall take office from the 1st of February. The President and one of the Vice-Presidents of the Society shall be elected each year by the Executive Council by circulation. No person shall hold the office of the President of the Society for a second time. The retiring President shall be one of the Vice-Presidents. Interim vacancies and other vacancies arising in the office of the Secretary, the Treasurer and the Councillors shall be filled by the Executive Council for the period of the interim vacancy. The Secretary, the Treasurer and the Councillors shall be elected by the members of the General Body.

(e) Four members to the Editorial Board shall be elected by the Executive Council for 4-year periods and retiring in rotation so that one is elected each year.

(f) The following procedure shall be adopted for all elections to office: The Secretary shall cause a list of members of the Society to be circulated before the 31st August in the year of election and invite from members entitled to vote nominations for each office falling vacant to be received before the 30th September. The Executive Council shall also nominate one member for each office falling vacant. For this, the Secretary shall invite the Executive Councillors to propose names for each office falling vacant to be received before the 15th September. The names so proposed by the Executive Councillors shall be circulated to them for voting and those obtaining the largest number of votes shall be considered as nominees of the Executive Council. The voting papers from the Executive Councillors shall be received before the 7th October. A list of names proposed by the members together with the nominations of the Council shall be

circulated to members before the 30th November of the concerned election year.

As a consequence the concerned rules are amended as follows:—

Rule No. 8.—Ordinary Members may become Life-Members upon payment of Rs. 250 either in lump sum or in instalments within a year from the time of their application for Life-Membership provided that any Ordinary Member who has already paid a number of annual subscriptions may be allowed a rebate at the rate of half the annual subscription paid, up to a maximum of eight years.

Rule No. 16.—Ordinary Members shall pay an admission fee of Rs. 5 on joining the Society. The annual subscription of Ordinary Members shall be Rs. 20. This shall be due on the first day of each calendar year and shall be paid in advance to the Treasurer.

Rule No. 31.—The subscription to the Journal from non-members shall be Rs. 30 or £ 2-10-0 or \$ 7.50.

Rule No. 24.—The President and Vice-Presidents shall serve for one year each and the Secretary, the Treasurer and Councillors for three years. The Councillors who have been in office for a term of three years shall retire from the Council and shall not be eligible for re-election until after the lapse of one year from the date of their retirement. The time of retirement of Office-bearers shall be 31st January in the concerned years and the new Office-bearers shall take office from the 1st of February. The President and one of the Vice-Presidents of the Society shall be elected each year by the Executive Council by circulation. No person shall hold the office of the President of the Society for a second time. The retiring President shall be one of the Vice-Presidents. Interim vacancies and other vacancies arising in the office of the Secretary, the Treasurer and the Councillors shall be filled by the Executive Council for the period of the interim vacancy. The Secretary, the Treasurer and the Councillors shall be elected by the members of the General Body.

Rule No. 29 (a).—Four members shall be elected by the Executive Council for 4-year periods and retiring in rotation so that one is elected each year.

Rule No. 33.—The following procedure shall be adopted for all elections to office: The Secretary shall cause a list of members of the Society to be circulated before the 31st August in the year of election and invite from members entitled to vote nominations for each office falling vacant to be received before the 30th September. The Executive Council shall also nominate one member for each office falling vacant. For this, the Secretary shall invite the Executive Councillors to propose names for each office falling vacant to be received before the 15th September. The names

so proposed by the Executive Councillors shall be circulated to them for voting and those obtaining the largest number of votes shall be considered as nominees of the Executive Council. The voting papers from the Executive Councillors shall be received before the 7th October. A list of names proposed by the members together with the nominations of the Council shall be circulated to members before the 30th November of the concerned election year.

5. (a) The following donors to the Society were thanked for the Annual Grants-in-Aid generously made by them for the year 1958-59 towards publication of the *Journal of the Indian Botanical Society* as also the donors who have generously made special grants towards publication of History Series:

	Rs.
1. National Institute of Sciences of India ..	2,000
2. Osmania University	300
3. Madras University	250
4. Banaras Hindu University	250
5. Utkal University	250
6. University of Kerala	250
7. Andhra University	100

Special Grants for History Series

1. Punjab University	1,000
2. Utkal University	1,250
3. University of Kerala	750

(b) The following were admitted to the Society as new members subject to their payment of admission fee and annual subscription.

1. Mr. Bhopinder Singh, Ahuja, Nasirabad.
2. Sharada Ratilal Desai, Vallabh Vidyanagar.
3. Miss M. Lakshmi Kumari, Madras.
4. Mr. B. S. Venkatachala, Lucknow.
5. Mr. T. K. Ramachandra Reddi, Madras.
6. Mr. D. Prabhakara Krishna, Amravati.
7. Mr. Hardev Singh, Delhi-8.
8. Mr. M. D. Krishnaswamy, Coimbatore.
9. Mr. M. Durairatnam, Ceylon.
10. Mrs. Susheela Santiago, Ambur.
11. Mr. K. M. Dakshini, Dehra Dun.
12. Y. P. Abrol, New Delhi.
13. Mr. Sitanath Das, Bhuvaneswar.
14. Mr. G. Varma, Almora.
15. Mr. R. M. Singhal, Sagar.

16. Mr. P. S. Ramakrishnan, Varanasi.
17. Mr. K. R. Ramanathan, New Delhi.
18. Mr. G. V. Subbarao, Calcutta.
19. Dr. B. D. Deshpande, Pilani.
20. Dr. Y. S. Sarma, Varanasi.
21. Dr. S. P. Mital, Ajmer.
22. Mr. S. C. Gupta, Delhi-8.
23. Shri K. B. S. Juneja.
24. Dr. K. N. Narayan, Bangalore.

6. The President for the year 1958, Prof. R. Misra, delivered his address to the Society on the 'Status of Plant Communities in the Upper Gangetic Plain'.

At the end of the address, a vote of thanks for the same was passed by the General Body.

7. The Hon. Secretary, Prof. J. Venkateswarlu, reported the results of the election of the Office-bearers for the year 1959. The votes were counted by Shri P. V. V. Seshagiri and Shri J. V. Pantulu who were appointed as scrutinisers by the President. The Office-bearers constituted for 1959 are as follows—

President : Dr. E. K. Janaki Ammal, Allahabad.

Vice-Presidents : Prof. R. Misra, Banaras; Prof. P. Maheshwari, Delhi.

Hon. Secretary : Prof. J. Venkateswarlu, Waltair.

Hon. Librarian : Prof. R. Misra, Banaras.

Hon. Treasurer : Prof. T. S. Sadasivan, Madras.

Councillors: Dr. I. Banerji, Calcutta; Prof. S. N. Das Gupta, Lucknow; Dr. A. C. Joshi, Chandigarh; Prof. T. S. Mahabale, Poona; Dr. P. Parija, Cuttack; Prof. V. Puri, Meerut; Mr. M. B. Raizada, Dehra Dun; Prof. S. Ranjan, Allahabad; Prof. R. P. Roy, Patna; Rev. Fr. H. Santapau, Bombay.

Members of the Editorial Board : Dr. B. P. Pal, Delhi (1956-59); Dr. A. C. Joshi, Chandigarh (1957-60); Rev. Fr. H. Santapau, Bombay (1958-61); Prof. P. Maheshwari, Delhi (1959-62).

Business Manager : Prof. T. S. Sadasivan, Madras.

A vote of thanks to Shri P. V. V. Seshagiri and Shri J. V. Pantulu (both members of the Society), Waltair, for kindly acting as counters was moved by the Hon. Secretary and passed for being communicated to them.

8. The retiring Office-bearers were appropriately thanked on a motion by the Hon. Secretary, Prof. J. Venkateswarlu. The President

thereupon thanked the Hon. Secretary in appreciation of his services to the Society during 1956-59.

The authorities of Delhi University, Indian Science Congress Association and particularly Prof. P. Maheshwari, Dr. B. M. Johri, Dr. S. L. Tandon, Dr. I. K. Vasil and Mr. S. C. Gupta of the Botany Department, University of Delhi, were thanked for all the help rendered by them in connection with the meetings and functions of the Indian Botanical Society.

A Group Photograph of the members of the Indian Botanical Society present was taken on 21-1-1959 at the Botany Department, Delhi University, Delhi-8.

ANNUAL REPORT, 1958

THE EXECUTIVE COUNCIL is pleased to submit the following Annual Report of the Society for the year 1958:—

1. The Thirty-Seventh Annual General Body Meeting of the Society was held on Monday, the 6th January 1958, at 11 A.M., in the Botany Section, Room No. 21, University Buildings, Madras-5, with Dr. S. K. Pande in the Chair.

The minutes of the meeting were published in the *Proceedings of the Indian Botanical Society*, 1958, which has already been circulated to the members.

2. The Annual Meeting of the Executive Council was held at 2 P.M. on Sunday, the 5th January 1958, in Room No. 21, University Buildings, Madras. Matters relating to the publication of *History of Botanical Research in India, Burma and Ceylon* and *Vegetational Types of India* were discussed and it was resolved unanimously that the publication of these articles be expedited. During the year three special publications, namely *Mycology and Plant Pathology*, *Systematic Botany of Angiosperms* and *Palaeobotany* have been issued. Besides these a Memoir No. 1 containing Symposia matter, namely, *Modern Trends in Taxonomy, Physiology of Micro-organisms* and *Floristic Studies in India* has also been issued.

3. An increase in the clerical allowances from Rs. 25 to Rs. 30 p.m. and from Rs. 60 to Rs. 100 p.m. at the offices of the Honorary Secretary, Waltair, and Business Manager, Treasurer and Chief Editor at Madras was considered and passed.

4. A Meeting of the Editorial Board of the *Journal of the Indian Botanical Society* was held in Room No. 21, University Buildings, Madras-5, on Sunday, the 5th January 1958, at 2-30 P.M. Prof. T. S. Sadasivan was unanimously elected as the Editor-in-Chief and Business Manager for the year 1958.

5. A group photograph of the members of the Indian Botanical Society who attended the Annual Meeting was taken on 6th January 1958, at 10 A.M.

6. An excursion of the Members of the Society to Vandalur was conducted and Prof. M. O. P. Iyengar accompanied and guided the party.

7. In accordance with the conditions of the generous endowment made by Prof. T. S. Sadasivan, the Executive Council has decided to award Birbal Sahni Medal for the year 1958 to Prof. P. Maheshwari for his outstanding contributions in Plant Morphology and Embryology and for his services to the cause of Indian Botany.

8. The financial position of the Society needs strengthening. The cost of printing the Journal has increased with increase in pagination of the Journal during the year. An audited statement of accounts for the year ending with 31st March 1958, has already been sent to the members as the Proceedings of the Society, 1958. There is a Reserve Fund of Rs. 14,500 in the shape of National Savings Certificates and this includes the amount of Rs. 2,500 donated by Prof. T. S. Sadasivan for founding the 'Birbal Sahni Medal'.

9. The following were published during the year:—

Journal of the Indian Botanical Society,

Vol. 37 [Nos. 1, 2 and 3 (mailed already) and 4 (in Press)].

A Supplementary List of Members, 1958, bringing up to date the changes in addresses, designations, titles, etc., of the members that were intimated to this office was published. The Proceedings of the Annual Meeting of the Indian Botanical Society, 1958, was also published and circulated to the members.

10. Membership:

(i) Honorary Members	..	8	
(ii) Life-Members	..	86	
(iii) Ordinary Members	..	366	
		<hr/>	
TOTAL MEMBERSHIP	..	460	including 299 Fellows.
		<hr/>	
Admission during 1958	..	77	
Resignations	..	4	
Not of Good Standing—Removed	..	14	
Members whose present address			
is not known hence removed		2	

11. Subscribers:

Indian	..	110
Foreign	..	120
Free Exchange		44